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Contents.

	PAGE
Forthcoming Events	399
Associations	399
The Safety Factor for Cast Iron	399
Some Aspects of Modern Foundry Practice	400
London Junior Foundrymen discuss Non-Ferrous Metals	402
Random Shots	402
Steel Castings	403
The Perran Foundry	404
Steel and Rail Cartels	404
New Companies	404
Sand Preparation and its Relation to Continuous Moulding	405
Hints on Non-Ferrous Foundry Practice	407
Institute of British Foundrymen	408
Mysore Iron Trade	408
The Mechanical Handling of Foundry Materials	409
Industrial Research	410
Close Works, Gateshead, Visited	410
An American Study of Liquid Shrinkage	410
Contributions to Charities	410
Notes on Alloy Steels	411
Catalogue Received	412
Trade Talk	414
Reports and Dividends	414
Contracts Open	414
Personal	414
Obituary	414
Iron and Steel Markets	416
Publication Received	416

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

DECEMBER 9.

Institute of Metals (Scottish Local Section):—Ordinary meeting at Glasgow. "Melting Furnaces," Paper by G. L. Cassidy.

DECEMBER 10.

Institute of Metals (North-East Coast Local Section):—Ordinary meeting at Newcastle-upon-Tyne. "Nickel in Non-Ferrous Foundry Alloys," Paper by W. T. Griffiths, M.Sc., F.I.C.

Sheffield Metallurgical Association:—Ordinary meeting at Sheffield. "The Spalling and Disintegration of Refractory Materials," Paper by A. T. Green, A.I.C.

DECEMBER 12.

Institute of Metals (London Local Section):—Joint meeting with the Institute of British Foundrymen in London. "Metal-Melting by Electricity," Paper by W. S. Gifford and D. F. Campbell, M.A., A.R.S.M.

Institute of British Foundrymen.

DECEMBER 7.

West Riding of Yorkshire Branch:—Ordinary meeting at Bradford. "The Future of the Foundries in Great Britain, with Special Reference to Continuous Casting," Paper by A. S. Beech.

Lancashire Branch:—Ordinary meeting at Manchester. "Nickel in the Iron Foundry," Paper by Dr. A. B. Everest.

DECEMBER 13.

Sheffield and District Section:—Ordinary meeting at Sheffield. "Coal-Dust and Facings in the Foundry: Some More Practical Experiments," Paper by H. Winterton.

Associations.

It is a common cry in industrial as in social life to-day that we are over-organised—that our activities are too much tabulated and shepherded into clubs, societies and institutions. Membership of each such association involves its own subscription, and although these sums are individually trivial they are collectively considerable. Such membership also involves some expenditure of time and energy, and here again the aggregate is no small matter. The solution is too often an indiscriminate refusal to join anything fresh, or even to join anything at all. Originally, of course, the industrialist, being himself employer and employed, satisfied his needs by a purely local association that consolidated the position of the craft in outside eyes and settled its purely internal problems. To-day nothing so simple will suffice. Employer and employed have parted company, and each requires his own association. Each craft has become immensely elaborated and subdivided, so that where one association formerly sufficed half a dozen are now called for. Simple rule-of-thumb jobs have become elaborate technical processes, demanding association and co-operation on the part of those concerned with them. Local problems have given way to national problems, national problems are in a measure giving way to international problems. Clearly the average man with average calls upon his time cannot give equal attention to all these aspects of his activities. The founder may be employer, ironfounder, metallurgist, engineer or chemist, and sometimes he is all of them rolled into one. How is he to make his choice between trade and technical, engineering and metallurgical organisations? Broadly speaking, it seems reasonable to suggest that he should belong first of all to that association which approaches most nearly the old craft organisation, because co-operation on this basis of process or function corresponds to a real human and social need. Men must know and meet other men engaged in the same job. Secondly, modern conditions demand some form of trade organisation to deal with problems of prices, problems of labour, problems of international competition. Thirdly, modern conditions also seem to demand a research organisation to keep the industrial unit in touch with the scientific work of the day and to prosecute such work on its special behalf. Beyond this the solution of the problem becomes a personal matter. Associations on a basis of material, locality, training, etc., may be extremely valuable in the individual case, but no general principle can be laid down with reference to them, whereas in the cases previously referred to there is strong ground for such a general argnment.

The Safety Factor for Cast Iron.

If there is a tendency for the notion of high tensile strength as a sole measure of high-quality cast iron becoming an obsession, the necessary corrective is to be found in a consideration of the allowable working tensile stress adopted by engineers. We are reminded of this matter by the remarks of Mr. Needham some few weeks ago, in the Engineering column of our contemporary "The Manchester Guardian." He reminds us that even to-day the allowable working stress for cast iron in tension is placed by many responsible engineers at 1.5 tons per square inch. Whilst Mr. Needham suggests that this might be regarded as caution carried to excess he regards the assumption of working stresses in tension for cast iron of four or more tons per square inch as taking a very grave risk. With the "Safety First" slogan in our minds, in spite of the increased confidence resulting from modern research, it is only possible to interpret Mr. Needham conservatively and to assume that even to-day the lifting of the limit of working stress in tension above 1.5 tons per square inch for cast iron would be unwise.

This limit of 1.5 tons per square inch as the working stress for cast iron is identical with that recommended by engineers half a century ago. This position is one which demands the attention of all who have the further progress of cast iron at heart. The maximum strength obtained by the metallurgist on his test-bar is the least important factor in the mind of the engineer who has to decide the allowable limit of working stress in a particular casting. The important factors are the liability to porosity and unsoundness; the possibilities of the existence of initial stress in cooling; irregularities in composition, mixture, and also in casting dimensions. In other words, the safety factor is a measure of the engineer's confidence in the casting as a whole. The direction of research with the ultimate object of improving cast iron is thus plainly indicated. We know that these aspects are receiving still more attention in modern research work and that work of this nature is much more arduous and considerably less spectacular than that of creating tensile strength records. The manifest importance of this matter justifies us in raising it for general attention.

XUM

Some Aspects of Modern Foundry Practice.

At a meeting of the Lancashire Branch of the I.B.F., held on Saturday, November 2, at the Manchester School of Technology, a lecture was delivered by Mr. F. Griffiths, of Rochdale, upon "Some Aspects of Modern Foundry Practice." In the absence of the Branch-President, Mr. E. Longden, owing to indisposition, the chair was taken by Mr. E. Flower, the Vice-President.

Mr. Griffiths said he intended to be practical and to put before the members the results of actual experience. What he had done they could do under similar conditions. He believed he could claim justly that the foundry he controlled was a modern one; it ought to be, because it was built about ten years ago, and one was able to procure modern implements and equipment for use in foundry work. At that time, also, in 1919, there were very few, if any, moulders to spare. Everybody was working at high pressure, so they had to dispense with moulders as far as possible and to replace them by labour-saving devices. That policy had been continued up to the present moment. It was not that the management wanted to employ unskilled men for the sake of cheapness. Personally he had been of the opinion for a long time that cheap labour was the dearest; in fact he could safely say in that foundry the lowest-paid producer was receiving higher wages than was the skilled moulder in their area.

Sands.

This branch of the subject he subdivided under three heads—qualities, treatment, advantages. They all had their own opinions—perhaps he should say fads—about the best sands for foundry purposes. He himself had in mind two kinds: sea sand, known to all of them, and Belgian sand, which was not so widely known. Probably they had heard of it and some of them might have seen it, because it was often used in steel foundries; but except his own firm he did not know any people who had used it for the production of iron castings. Everybody was agreed about the efficacy of sea sand for cores. Any foundry which did not use this type for that purpose was making a mistake. The astonishing progress in the use of oil-sand cores was a proof of this. He hoped to prove that it was also excellent for facing sand. Usually the first ingredient associated with it was an expensive oil, but he did not think the necessity for that was as great as some people claimed it to be. Sea sand itself was entirely without bond.

Belgian sand was a highly-bonded sand. In his judgment, based upon experience in the foundry where he worked, and upon what he had seen on his visits to other foundries, only two sands were needed for any foundry—sea sand and Belgian sand. The latter might be considered expensive in initial outlay, but experience showed that it was by far the cheapest sand procurable, for the reason that a very small percentage of new sand was needed for renewal in the form of facing sand. In a load of it one could pick out lumps of what could be called clay, and an English sand which contained such material would be regarded by foundrymen as of no value for their purposes. If the new sand was milled for three minutes, it had the appearance and the bond of ground clay. The sample submitted showed that. Yet, in spite of this, the sand was extremely porous. Four properties or qualities were generally considered to be necessary to constitute a good sand. It should be refractory, it should have a high bonding strength, it should have permeability or porosity, so as to allow the escape of gases, and it should be durable. He could safely claim that Belgian sand had those qualities.

Treatment of Sand.

An excellent "facing sand" could be produced at very low cost, the formula of which was: Old sand, 91; Belgian new sand, 7, and coal-dust and oil, 2 per cent. The very best facing sand (known as brown facing sand) was constituted as follows: Old core sand (sea sand), 80; new sea sand, 8; Belgian sand, 10, and dextrine and oil, 2 per cent. The formula for ordinary core sand was: Old core sand, 32; new sea sand, 64; Belgian sand, 1½; dextrine, 1, and crude oil, 1½ per cent.

As previously stated, the core sand could be used time and time again for facing sand as well as for diluting new sand for making cores.

The treatment of backing sand called for special mention. The practice in most foundries was to add water to the sand, after the castings are removed, turn it over and riddle it or disintegrate it, or plough it. The employment of Belgian sand, however, compelled one to remove it entirely from the foundry floor to a sand-mixing depôt and return it to the moulder ready for use. In connection with this matter he was impelled to ask, why should not the sand be given to the moulder ready for use? No one would dream of requiring the coremaker to make his own sand. It was prepared for him. Why should not the moulder have the same treatment and be relieved of the arduous labour of mixing sand? The plant required for such operation might be an ordinary mill, such as is in common use in most foundries, or by the modern labour-saving devices in use in the up-to-date foundries. In their own case the whole of the sand was formerly milled in the mortar-mill type of machine. Six men were engaged in preparing all the "backing sand" and "core sand" and "facing sand," working eleven hours daily, and three mills in operation. The work was now done in the Simpson "Intensive" mixing machine and one of the previously mentioned machines, by four men, at much less power cost, working nine hours daily.

He had seen and experienced "mechanical" devices (and also suction plant mechanism) for removing sand from the foundry floor to the mixing depôt, and afterwards carrying it back to the moulding machine or to the moulder; but in no case did he consider the results were as satisfactory as their present practice of dealing with the sand by hand. It was as follows:—

The night-workers were engaged in removing castings and sand from the foundry floor, the sand being loaded into rectangular receptacles (such as building contractors use) of the following dimensions: 5 ft. by 3 ft. by 3 ft. 6 in. The holding capacity was 30 cwts. Sand was thus conveyed by a crane and tipped behind the Simpson mixer, situated at the end of the foundry. From that place the sand was shovelled into the bucket loader of the mixer, to the amount of about 12 cwts. per load, elevated and deposited into the mixer; an attendant added the necessary amount of water; and, when sufficiently milled, a door was opened and the sand fell on to a revolving drum (which operation disintegrated it), and thence into the receptacle already mentioned. It was then stored, ready for distributing to the moulders as they needed it. It was worthy of note that, by a proper arrangement of the sand receptacles, 30 tons of sand could be stored on a floor area 20 ft. by 8 ft. A matter of 15 tons of sand was used in the production of one ton of castings.

Advantages of Belgian Sand.

Every mould made in Belgian sand must be rammed very hard, yet venting was unnecessary, particularly when brown facing sand was used. It was the practice for the moulder to shake plumbago on the pattern. Then, when the mould was lifted from the pattern, it was perfectly clean and clear; there was no need to use water. No moulder and no coremaker used a drop of water; they did not know the meaning of the "swab pot." The necessary amount of water was added in the sand-milling operation.

Generally speaking, every mould, whether made from a loose pattern, or plate pattern, or machine moulded, could be rammed up and lifted away from the pattern without the use of gaggers. An idea of what the moulds were like would be gathered from examining the mould [submitted]. The castings [exhibited] were just as they had been lifted out of the mould; no treatment had been given to them. They showed the excellent surface produced on them by the use of Belgian sand.

It was surprising what could be done with large bedplates up to 3½ tons. They, too, might be made without venting or any "sleeking" whatever. The cores served the useful purpose of acting as a "cope," and the sand was recovered and made into excellent facing sand or core sand. The models submitted would doubtless convey to his hearers how such moulds could be produced economically.

Moulding Machines.

He was a convert to the jar-ram type of machine. The most useful machines to him were the roll-over machine and the jar-ram machine, with the pattern drawing attachment of the type which lifted the mould from the pattern. Jigs were used for every type of box, and fitted to the table of the machines; the models submitted would make clear how the patterns mounted on boards were inserted into the jigs.

Pinless moulding boxes were used exclusively and all were "jig"-drilled; in very many cases no bars were cast in the boxes, and it was common practice to make moulds in boxes 4 ft. square, with a depth of from 8 in. to 16 in. without the use of "gaggers" and without any bars in the boxes. This was a tribute to the high binding quality of the Belgian sand.

The Cupola.

Every foundryman had his own opinions about cupola practice. He had before him a model of the "syphon brick," which probably some of those present had seen in operation. He had used such bricks in his cupola for six years, it was a device instituted by M. Ronceray. By inserting the syphon brick there was no "tapping out" of the metal and botting in such as they were all accustomed to in ordinary cupola practice. The brick was made of ganister, and produced by the use of a core box. One brick lasted three months, or longer, and was easily replaced when necessary.

It would be observed that there were two "tapping" holes, the higher one connected with the lower one by a channel formed inside of the brick. The lower hole was in line with the inlet hole inside the cupola. The effect of using the syphon brick was to get very hot metal away from the cupola as quickly as it was melted.

Vote of Thanks.

Mr. A. L. Key said Mr. Griffiths evidently knew his business, and it was very pleasing to observe his readiness to let other people know what he had done. The splendid manner in which he described the processes, the materials, and the methods, deserved a very hearty vote of thanks, which he moved. Mr. Dudley seconded the vote of thanks, and it was passed unanimously.

DISCUSSION.

Pinless Moulding Boxes.

The discussion was opened by Mr. Key, who asked what was the output of the foundry Mr. Griffiths had been dealing with, whilst information as to the jig-drilled boxes would be of service. In his own foundry they used boxes 16 in. long by 6 ft. wide, and none was drilled. They were cast purposely with a large hole in the lug. They had standardised brass bushes, which were $\frac{1}{16}$ in. thick. The box was put on the pattern plate, and over the register pins. A bush was then placed over the pin; and the

space between the bush and the hole in the lug was filled with a plastic metal. No matter how long it had been exposed in the yard the hole was just as good as it was when the box went out. If there happened to be a bad hole the bush was removed and replaced on the plate again. In many cases where a hole became damaged whilst the man was filling the box, the handyman came along with a fresh bush, and he would run that bush in without causing any delay.

MR. GRIFFITHS said the output of the foundry was 35 tons a week, and the average weight of the castings was about 14 lbs. With regard to the boxes, they began with the method Mr. Key had mentioned, but they had no success with it. It frequently happened that when the metal ran out at the box joint, it melted the white metal which surrounded the bush, and then the box had to be rebushed; so they discarded that method and had the boxes drilled.

Making Thin Castings.

MR. T. W. MARKLAND said he had been wondering whether the moulding sand described could be used advantageously in his own case. He made castings $\frac{3}{16}$ in. thick, and the surface must be free from veins or scratches. They were somewhat dissatisfied with their present practice, but did not want to make a change unless they were sure of their ground. It seemed to him from the description given that this Belgian sand, with hard ramming, would suit their class of work. It was mostly plate work. Did Mr. Griffiths think the Belgian sand could be used to advantage in thin castings? He would like to know also what class of castings Mr. Griffiths had been making. From what he had seen he judged they were electrical work. Had Mr. Griffiths made castings in any other class of work?

MR. GRIFFITHS said it was electrical work. They had made a large amount of engine work, bedplates, crank cases, etc., weighing about 25 cwts., down to castings weighing a few ounces. What was the size of casting Mr. Markland had in mind?

MR. MARKLAND replied the dimensions were 12 ft. wide, 6 ft. long, and $\frac{3}{16}$ in. thick. It was necessary to have a good surface before the casting went to the polisher; all marking must be avoided.

MR. GRIFFITHS said the thinnest casting they made was one-sixteenth thickness. Judging from his experience, if plumbago was put on the pattern first and it was rammed hard, he would have no doubt whatever that the castings made in the sand would have a good surface, especially so if what he had described as the best facing sand were used.

British Sand Replaces Belgian.

MR. MASTERS said Mr. Griffiths' remarks bore out several statements which he himself made at the previous meeting of the Branch when discussing the question of coal dust. He then stated that it was possible to make green sand castings without coal dust. In his opinion, sand could be got in this country which, if suitably treated, was of equal value to Belgian sand. Twenty-four or twenty-five years ago he made some fairly large wheels with very fine teeth, and the idea occurred to him to make them in Mansfield sand and sea sand. There was no coal dust or anything of that nature put in. The mixing was 40 per cent. sea sand and 60 per cent. Mansfield brass moulding sand. Those fine teeth came out beautifully sharp, it was a job satisfactory to everybody concerned. The cost was not the chief consideration. The main object was to get a good casting. Every one of those castings was a success. The sand was mixed in what he might term a tread-wheel mill—a very light mill—and later it was put through a revolving riddle. Mr. Griffiths' Paper proved conclusively, in his opinion, that with a little artificial bond in the material it was possible to make successfully and economically castings up to the weight of about 7 tons, according to section, without coal dust. The method of handling the sand which Mr. Griffiths described rather surprised him. He should have thought a conveyor arrangement would be more economical in the long run than to have men handling and lifting the sand. Mechanical aids were becoming more common in foundries. Recently he had the pleasure of visiting one of the biggest modern foundries in this country where everything had been mechanised, and much money had been spent to eliminate laborious work.

Mixing Technique.

MR. REYNOLDS asked whether the lecturer made any attempt to control the amount of moisture in the sand, or did he find that the addition of oil affected the properties of the sand? On several occasions he had been told by people who travelled that the reputation some of the French foundries had (and also some of the Scotch and Midland foundries) for the finish upon their castings was due to the fact that the sand was kept very dry. In some cases the sand was actually dried, and then a predetermined amount of moisture was added. Did Mr. Griffiths think the oil influenced the distribution of the water or prevented it from having any ill effects? He had had some experience of Belgian sand, but in his foundry it had been replaced by English sand of similar grade and quality, which cost much less. For two years they had not imported any Belgian sand, and they were not aware of any deterioration in the quality of the castings. In fact there had been a definite improvement.

MR. GRIFFITHS said he did not think the addition of eight pints of oil to 14 cwts. of sand would affect its properties. In the milling operation the man in charge added sufficient water, which his experience determined. If the sand happened to be too wet it made very little difference, it did not seem to affect the casting adversely, especially if all the sand was not wet. The whole 30 cwts. in one tub, if not all wet, it did not seem to do harm. The matter was left to the man in control, who was an ordinary labourer, but had more than the average labourer's knowledge. He was first interested in this question of moisture when he visited a Midland foundry, which used Belgian sand, and he noticed that when the mould had been cast—this was on steel work—the top part was knocked out on to the floor and a man would shovel it up again. The sand in the bottom box was taken back to the mill, prepared, and brought back, in rather dry condition. They themselves began with that method, but the result was that dirt marks appeared. These were revealed when the castings were sand blasted; so they made the sand a little bit wetter.

In saying there were no gaggers or almost none, he did not mean that it was absolutely so in a deep lift. If, when the mould was rammed up, one had to make a deep joint, gaggers were rested against the side of the box, not coming through it, as is usual. He had not noticed any difficulty or any undue trouble from the top-part falling out. Quite a large proportion of the boxes had no bars at all, even in boxes which were 4 ft. square and from 8 in. to 16 in. deep.

Importance of Backing Sand.

MR. W. H. MEADOWCROFT said he gathered from Mr. Griffiths' remarks that the efficiency of the plant had a great deal to do with the results obtained. That encouraged the hope of getting better results from older plants. It was the first time he had seen Belgian sand, but the sample handed round reminded him of a very similar sand, though of a coarser nature, which was in use in the United States when he was out there some years ago. It was very tough, and great liberties were taken with it in comparison with what British foundrymen did with the ordinary red sand they were accustomed to use.

What was the object of taking away from the moulder the preparation of the backing sand? Apart from the saving of labour, he took it, the only reason was to enable a thorough mixing to be made in the ordinary way. The sand did not undergo any special treatment beyond being thoroughly aerated and mixed. It was then delivered in perfect condition to the moulder. That seemed to be a very good idea if it was practicable. There was no doubt the condition of the backing sand had a great effect upon the casting.

When one had become used to the old-fashioned way of turning the sand over and riddling it, a surprising difference was made by employing a good aerating machine. He had not tried the mixer Mr. Griffiths mentioned, but he gathered from the description that it was very suitable.

Mixing Details.

MR. GRIFFITHS said the introduction of the Belgian sand gave an impulse to milling. The casting was knocked out and removed, and the crane slung the sand over. Nothing was done to that sand except that two or three men shovelled it into an elevator, which carried it to a mill. The man stationed there added water; when he judged from the change in colour that it had enough water, he operated a lever, a door opened, and the sand was thrown out on to a revolving pulley. It was disintegrated and deposited in one of the 30-cwt. receptacles. One of those receptacles was placed under the disintegrator and another was brought up to it. By taking off a cover which was over the disintegrator the throw could be regulated. As the tubs were filled they were removed and others put in their place. In two minutes 12 cwts. of backing sand was mixed, made ready for use, and taken out. That happened under ideal conditions when the crane could remove the full tubs and put the others in place. The idea really was to mix it and add water to it. Milling made the water percolate through the grains of sand more readily when it was broken up and came from the disintegrator. Crude oil was used throughout for making cores and everything else.

In reply to a question by Mr. Lowe as to whether, without the addition of oil, the Belgian sand could be used for light castings, Mr. Griffiths insisted that it could, and would be more expensive if one used coal dust alone. Moreover, one would get a duller surface on the casting.

MR. LOWE cited the objection that there may be an obnoxious smell through the use of oil.

MR. GRIFFITHS agreed that was so, if the mould was disturbed. When the mould was not disturbed there was no more ill-odour than what is obtained from oil cores in ordinary every-day foundry practice.

MR. J. JACKSON said it seemed to him the point raised by Mr. Lowe was vital. Was the merit of Belgian sand, its supposed superiority over English sand, due to the method in which oil was mixed with it, and how were its properties affected by the oil? If it were used as most sands were used in this country—treated with water in tempering it—would it show the same great merit or not?

MR. GRIFFITHS said he had no doubt it would have the same merit. It should be noted that only water is added to the backing sand in the milling operation. Oil was added to the facing sand, for the purpose of giving a better surface on the castings. One may use the sand by adding coal dust alone, as one would to any English sand.

In reply to a question by Mr. Sutcliffe, Mr. Griffiths said that in ordinary facing sand he used 1 per cent. of coal dust and 0.75 per cent. of oil. One can dispense with the oil if necessary.

MR. SUTCLIFFE also inquired whether Mr. Griffiths had any perished sand, sand which was not re-used but was thrown away. He noted that the cost of the core sand was 7½d. per cwt.

He had made cores for castings up to 12 tons weight, and the sand used for the cores cost him 2½d. per cwt. That was made from floor sand. The price of the raw red sand was 12s. 8d.

Mr. Griffiths said they could not do it better than 7½d. for the core sand and 2½d. for facing sand. They used much more core sand than they could cope with, and they had to tip large quantities of it. They also had an accumulation of Belgian sand, but he had found that by taking it outside, weathering it for 12 months, and bringing it back again, it was much improved.

Non-Ferrous Work.

Mr. Masters asked whether Mr. Griffiths had tried Belgian sand in making castings of non-ferrous alloys; if so, with what result?

Mr. Griffiths replied that they required to be rammed hard, just as in the case of ferrous castings.

Mr. A. Jackson said he would like to hear something further about the cost of the syphon brick, and whether it was difficult to apply to a cupola running two blows a day. Had Mr. Griffiths tried it out on a cupola which had the tapping hole in the breast, and which was not of a deep bottom type?

Mr. Griffiths said it was easy to make the brick. It was not expensive, and was made in the core box in just the same way as one would make a core. A fresh brick could be inserted every day if necessary. Their cupola was of the ordinary type, not like that Mr. Jackson had referred to, and there was no necessity to knock out the whole arrangement every day.

The Chairman (Mr. E. Flower), in closing the discussion, said his first question had reference to the making of a large bed 20 tons in weight. They all knew the usual method of starting a job of this description was to make a hole in the floor deeper than what was actually required, in order to accommodate a layer of cinders which would ultimately form a gas producer, for no reason known to the speaker, except to comply with the usual custom; could the method advocated by the lecturer be adopted for this class of work, without drying or venting? The moistening of the sand seemed to be done in a haphazard fashion, which was rather contradictory to the principle of not allowing a "swab pot" to be used in the shop. Was it essential for the backing sand to be returned to the mill for milling after every cast, or was it just simply to save the time and energy of the moulders? They were much indebted to Mr. Griffiths for his goodness in giving the members the benefit of his wide experience on this subject.

Mr. Griffiths replied that a bed of 20 tons weight was a serious thing, and he would not take the risk of postulating, without a previous trial, whether the method could be applied to such a case. The risk of spoiling a 20-ton casting was not to be taken lightly, but his experience justified optimism, and he thought it could be done.

The watering of the sand might appear haphazard, but in reality it was not. The man who did the work was thoroughly accustomed to it. The ordinary backing sand must be re-milled to get the best results.

Size of Blast-Furnace Coke.—Prof. Walther Mathesius introduces a short communication in a recent issue of "Stahl und Eisen," by the remark that the depth of penetration of the blast into the furnace chiefly depends on the number of obstructions it meets which cause deviations in its direction, and hence on the size of the coke used. The correct size of the coke for any furnace depends on the reactive capacity of its surface and the rate at which the furnace is run. For the production of white iron, where a rapid rate is required, small coke will give the best results, whereas for the production of grey iron, which is a slower process, larger pieces of coke will have to be used. The optimum size will have to be settled by systematic experiments.

London Junior Foundrymen discuss Non-Ferrous Metals.

A meeting of the London Junior Section of the Institute of British Foundrymen was held on November 29 at the offices of The Foundry Trade Journal, when Mr. H. C. Dews gave an instructive talk upon "Some Interesting Notes on Brass and Bronze." Mr. H. R. E. Slater occupied the chair.

Mr. Dews first emphasised the elementary but often confused fact that the brasses and bronzes constitute two distinct series of alloys. Complex brasses are, however, sometimes called bronzes. Brass is composed of copper and zinc, and bronze of copper and tin, but each alloy—of which there are numerous varieties—may contain small percentages of other alloying metals.

The zinc content of brasses ranges from 30 to 40 per cent. Up to about 35 per cent. the crystals are in α solid solution; when nearer 40 per cent. they are in β solid solution. The α solid solution is very ductile, the β solution is less ductile but harder and stronger. The metallurgy of brasses and bronzes rests largely upon the regulation of the α and β contents. Most of the additional alloying metals may be reduced to a zinc base. Thus the zinc value of tin is 2, of aluminium 6, iron 0.9, etc. Nickel has a negative value of − 1.

Lead, however, will not go into solution as do other metals, as, therefore, it has no zinc value, it cannot affect the α and β relation. It is free. When 3 to 4 per cent. of lead is introduced, it sinks to the bottom of the pot, consequently, either the last two or three castings are composed of nearly pure lead or, in pouring a large casting, the bottom will consist of lead. It is, therefore, kept down in brasses to about 2 per cent., being introduced because it improves the machining and hot-working properties of the metal. Tin replaces two of zinc and strengthens the metal much more than one would expect from the amount of β it produces. It also improves the resistance to sea-water corrosion—the Admiralty specifies a tin content of 2 per cent. for condenser tubes. Aluminium, about 2 per cent., also imparts anti-corrosion properties. Manganese, even ¼ per cent., reduces grain size considerably and refines the metal.

Bronzes contain up to 25 per cent. tin. The bronze, containing 5 per cent. tin, is used for strip, wire, sheets, rods, bars and springs for instrument parts, and never contains more than 7 per cent. tin for commercial use. If there is more, β is found, and as the alloy cools, this β decomposes into δ, which is hard and brittle and cannot be worked. An addition of ¼ per cent. of phosphorus, which has a tin equivalent of 12, hardens and strengthens the bronze.

Of the 10 per cent. tin bronzes, the most common one is Admiralty gun-metal. This popular bronze is used particularly for meeting hydrostatic tests where liquid pressure must be restricted. The zinc content, which sometimes exceeds 2 per cent., increases fluidity considerably, and the 88:8:4 alloy is commonly used. Lead is added to improve machining properties; it has no great liquation effect; it decreases the strength but renders the alloy easier to cast.

Phosphorus is introduced in bronzes for two entirely different purposes. Primarily, about 0.01 per cent. is added and solely for deoxidising the tin oxide in the bronze. In the second case, it is used to form a phosphor-bronze and ranges from 0.1 to 1.0 per cent. This phosphor-bronze is used chiefly for bearings.

Mr. V. C. Faulkner proposed a hearty vote of thanks to Mr. Dews for his extremely informative lecture, and Mr. Slater, the chairman, seconded. The discussion was opened by Mr. Faulkner and enlarged several points, for which Mr. Dews had not had time to discuss at length.

Random Shots.

I see that a Parliamentary Science Committee is being formed at the present time. . . . In the course of a long connection with our metallurgical industries I have made the acquaintance of a great many scientific gentlemen, including nearly all the leading metallurgists, and if there is one conclusion that I feel entitled to draw, it is this, that science and politics are as the poles apart. Efforts have been made from time to time to interest scientific workers in politics, and I have yet to hear of one of them being successful in the sense of winning the confidence and interest of a serious number of leading men. This new effort is embarking on the presumably more grateful task of interesting politicians in science. Nevertheless, if this is to be done adequately it must involve co-operation. It would be a pity if our politicians were roused to an interest in science only to have it satisfied with the second-best.

* * *

As a matter of fact, in common with most practical folk, I cannot help deploring this aloof attitude on the part of so many scientific men. I understand and appreciate their desire to devote their best talents to a specialised field of work; but by so doing a great many of them are led to take a narrow and uninformed view of affairs in general. This is bad, because it deprives the said "affairs" of valuable potential assistance, and it is bad for the scientists themselves because it cuts them off from the current of popular life, and so lessens their influence and that of the work they do.

* * *

Talking of science, and so of research, I discovered a number of things in the course of a more than usually intensive study of our technical contemporaries. (You must blame the long evenings; I'm not usually given that way!) In particular, I found that two of these publications have been having quite a pointed argument about the relationship that should subsist between research associations and technical institutions. I will only say that one of them is a weekly and the other a monthly, and leave it at that. This particular argument related primarily to the non-ferrous trades; iron-founding fortunately is not torn asunder by these little differences.

* * *

There are a number of signs that the Diesel engine, with its use of heavy oil instead of steam and petrol, is making rapid strides to favour. I remember about two years ago that the announcement of an oil-fired ship was in the nature of an event; now we have not only ships, but railway locomotives, aircraft, and, most recent of all, steam rollers and lorries! The recent Road Exhibition at the Agricultural Hall made this clear, for there were plenty of steam-rollers of all sizes, though the lorry was still a lonely newcomer.

* * *

The advantages of this lorry were demonstrated in a variety of ways, but the one most attractive to the lay mind was the presence of a beaker of heavy oil with the invitation to use it as a receptacle for dead matches! I believe that the same point is demonstrated to visitors at Cardington, the home of R101, where a bonfire is specially lighted in order to be extinguished by a bucket of fuel oil! The reflections to which this gives rise are somewhat varied. . . The lesson that the public are expected to learn is the lesson of greater safety; but I believe there are some who see in these encroachments of the heavy-oil engine a not unwelcome threat to the petrol tax.

Marksman.

XUM

Steel Castings.*

By C. Howell Kain.

PART I.—Metallurgical Considerations.

Last winter, attention was drawn to steel castings by a symposium on the subject held in Glasgow. Papers were read which stated the engineers' requirements, and showed that their demands are becoming more and more exacting as a result of higher engine speed, greater pressures and elevated temperatures. These Papers were followed by others dealing with the difficulties encountered by both the metallurgist and the moulder, and a general discussion was held on the whole subject. This conference took the subject a step nearer to a more sympathetic understanding between the engineer and the founder. The following is an account of how some of the problems mentioned are being dealt with in an electric steel foundry.

As is well known, in the basic-lined electric furnace, it is possible to have either oxidising or reducing conditions at will, and as a result of this many melters are apt to be somewhat careless in the conduct of the first operations in making a heat of steel, because they have an impression that the final reducing slag will cure all evils, and no one is more surprised than they when, after tapping, the steel is wild, and possibly even rising or sluggish, and showing a lack of "life." Since every stage or operation in the making of a heat is under control (the speed of melting being checked by careful charging and manipulation of the power input, the oxidation of C, Si, Mn and P being controlled by the ore additions and not subject to the action of flame and furnace gases as in the open-hearth process, or atmospheric oxygen as in the converter, and the finishing or killing being done under ideal reducing conditions), many theories have been advanced to explain the lack of "life" of electric steels.

Experiments for Prolonging "Life."

Some little time ago experiments were made with a duplex process for special irons. The process consisted of melting a high percentage of steel scrap in the cupola and finishing the metal in the electric furnace, and it was decided to try the process a step further for the production of steel. The metal as received from the cupola contained 2.4 to 2.6 per cent. of carbon. This was "ored-down" to 0.1 per cent. or so, and the oxidising slag removed. The progress of the reduction of the amount of the oxidisable elements was very carefully followed by the analysis of samples, and the ore additions carefully controlled, so that there should be no great excess of iron oxide or gases present, when the carbon was lowered to the desired figure. Since the ratio of the ferrous oxide in the slag to the ferrous oxide in the steel is a constant at any given temperature, then, as the carbon is lowered, the ferrous oxide concentration in the slag must be lowered also, otherwise too great a quantity of oxide is left in the steel after the removal of the oxidising slag, to be efficiently reduced in a reasonable time by the action of the final reducing slag, and manganese and silicon additions. Unfortunately, this is very often forgotten, and it is not uncommon to see a first slag being removed whilst a very vigorous boil is still proceeding. This was borne in mind during the "oreing-down" of the high-carbon heats, and, when the first slag was removed, the bath was boiling very gently. The finishing or reducing slag was then built up, and the heat finished as quickly as possible by ferro-silicon and ferro-manganese additions.

The steel, when tapped, had a remarkable resemblance to converter steel in its life, ability to run very thin sections and good casting properties, etc. No extra heating was obtained from the oxidation of carbon, as the chilling effect of the cold ore balanced the heating effect of the oxidation, and also the reaction was not rapid enough to allow this heating to take place. Hence, the steel, when tapped, was not unduly hot to cause the fluidity. In addition to this, there was a complete absence of wildness in the heats made, and no signs of porosity in any of the castings.

Inhibiting Lack of "Life."

From a study of these experiments it was concluded that, in order to overcome the lack of "life" commonly experienced with electric steels, it is necessary:—(*a*) So to arrange the composition of the melt that there is no free ferrous oxide formed whilst the metal is unprotected by a layer of slag, and is being melted by the fierce heat of the arc; (*b*) so to control the ore conditions that there is little or no excess of oxide present at the end of the oxidation period. Otherwise a very long and very strongly reducing period is necessary, and this is always followed by a lack of "life" in the steel; and (*c*) to work the heats as quickly as possible.

Since these experiments, all the charges in the electric furnaces are carefully arranged so that, after melting, the bath contains not less than 0.35 to 0.4 per cent. of carbon, preferably about 0.6 to 0.8 per cent. As a result of this, and the practice of great care with the ore additions and fast working, practically no trouble is experienced from lack of fluidity. But it is very important that the heat should be ored down and finished as quickly as possible, otherwise no advantage is gained in "life." The effect of rapid working is quickly lost under the action of the reducing slag, and endeavours should be made not to have the metal under the influence of this slag for more than a maximum of about 40 to 45 minutes, if it is desired to tap a steel suitable for lip pouring from small hand shanks.

TABLE I.—*Influence of Process on "Life" (M'Cance).*

Process.	Electric.	Acid O.H.	Bessemer.
Sulphur	0.020	0.045	0.060
Phosphorus ..	0.020	0.040	0.055
Oxygen	0.025	0.040	0.080
Total ..	0.065	0.125	0.195

Process, "Life" and Calcium Carbide.

Table I is taken from Dr. M'Cance's Paper to the Glasgow Conference on steel castings, and was given by him as a possible explanation of the lack of life of electric steels. It will be seen that the total amount of really harmful elements—sulphur, phosphorus and oxygen—is much less in the electric steel than in the open-hearth, or converter steel. Although the author is inclined to think that the figure of 0.06 for sulphur in the converter steel is rather higher than that obtained by the best practice to-day. Whether the increased life of the steel, made by the method described, is due to an increase in the oxygen content, one cannot at the moment say, as the estimation of oxygen is rather outside the scope of the ordinary works' laboratory. If oxygen is the cause, it might be present either as an oxide of iron, or as an oxide of carbon, since both these are formed in the process described, but should be effectively removed during the finishing period. Again, it has been suggested that lack of life is due to the presence of calcium reduced from the lime or dolomite, and it is thought to be general experience that whilst calcium silicide is a very efficient final killing agent, it tends to give a sluggish steel. If calcium is the cause, then, by melting a hard bath and causing a sharp boil by the addition of ore, is it not possible that the calcium is removed by the mechanical action of the boil, since it is suggested that the calcium is present as very finely disseminated particles? This is another point difficult to tackle in a works' laboratory, and it would be of interest to have it investigated by a research worker.

The above is, of course, a very brief outline, and does not mention, for instance, the correct temperature conditions for the elimination of phosphorus, or the maintenance of a correct slag for the removal of sulphur, but it does show what can be done to overcome one of the difficulties of melting practice.

Effect of Silicon and Manganese Obscure.

The action of silicon and manganese additions is also a question upon which more accurate information is required. This refers, of course, to the plain carbon steels, and not to special steels such as manganese steel or high-silicon steels. It is the usual practice to add a fairly large quantity of ferro-silicon to the bath immediately after the removal of the oxidising slag; further additions being made as the heat progresses through the reducing period. This is not good practice, because ferro-silicon is then being used to reduce ferrous oxide, which ought to be reduced by the slag. Lime and coal are cheaper than ferro-silicon, so why use silicon for work which can be done by coal or coke breeze?

At the moment the best practice appears to be to build up the reducing final slag, and not to add any ferro-silicon until the slag is white, and after quenching in water evolves acetylene. This is proof that there is no oxide present in the slag, and, from the ferrous oxide in slag to ferrous oxide in metal ratio, little or none in the metal. Ferro-silicon is then added in small amounts to degasify the melt, since there are still large quantities of carbon monoxide and carbon dioxide present in the metal. The exact action of silicon is not known, but it probably acts in this case by increasing the solvent power of steel for gases.

A number of heats were run with the object of studying to some extent the action of silicon, this being done by the comparison of the silicon added to that left in the metal at tapping.

TABLE II.—*Yield from Silicon Additions.*

Method.	% Si added.	% Si in steel.	Yield %
Si addition after slagging off. Al added to ladle ..	0.446	0.262	58.7
As above. Ti added to ladle	0.419	0.308	73.5
Si additions only after second slag. Ti added to ladle	0.208	0.286	137.5

Table II shows the results obtained. Each of the figures given here is an average of not less than six heats, so they are not isolated instances. All the heats were run as nearly as possible under identically the same conditions during the melting and oxidation periods. In the first two instances ferro-silicon was added to the bath immediately after the removal of the oxidising slag. In the third instance no silicon addition was made until a perfect reducing slag was obtained. In the first case, aluminium was added to the ladle as a final deoxidiser, and in the second two cases ferro-titanium was used. It is difficult to say why there should be a greater yield of silicon when using titanium than when using aluminium, but apparently the titanium has reduced some of the silica formed on the first addition of FeSi to silicon and titanium oxide. It is, however, obvious that in the first two instances a large part of the silicon has passed to the slag as silica. Theoretically, this ought to be reduced back to the metal, but

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* A Paper read before the London Section of the Institute of British Foundrymen. Mr. J. W. Gardom presiding. Mr. Kain is foundry manager to Messrs. Lake & Elliot, of Braintree.

this does not appear to have occurred. In the third case, apparently no silicon has passed into the slag as silica, but the whole of the amount added has remained in the metal together with some which has been reduced from the slag, probably from the fluor-spar added to thin out the slag, or from silica drippings from the roof.

As all the heats run had perfect reducing slags, it is difficult to visualise the conditions which have caused silica to be reduced back into the metal in the third case and not in the first two. Possibly the silica formed in the first two instances exists in the metal as chemically pure silica, whilst in the third case the silica is present in the form of complex and easily-reducible silicates. Again, in the third case, as the bath is naturally much quieter when the silicon is added, there is not so much tendency for the silica or silicon, immediately after skimming in the metal, to be removed mechanically by the boil.

Zirconium a Powerful Deoxidiser.

Experiments were also made in the same manner, but adding ferro-zirconium silicon instead of plain ferro-silicon. A very much higher yield of silicon is obtained, but the figures are not shown, because the presence of zirconium with its strong deoxidising powers, renders the figures non-comparable, and its use depends largely on considerations of cost, since it is more expensive than ferro-silicon.

Final Degasification by Al and Ti.

After the metal has been properly finished and killed, it is the universal practice to use a final deoxidiser or degasifier, such as aluminium. Some founders add this to the metal in the furnace just before, or during, tapping, whilst others prefer to add it to the ladle, and at a meeting of the American Society for Steel Treating, held in Chicago on September 10, Major Bull recommended adding aluminium to the metal stream just as it enters the mould. This is very bad practice, as the product of the reaction, alumina, is entrapped in the metal of the casting, since freezing is proceeding very rapidly all round it, and it cannot separate. Alumina inclusions are glass hard, and such inclusions are fatal to rapid machining. Also, as the aluminium has no opportunity to become thoroughly scattered and permeated through the metal, the inclusions tend to be quite large, and in the case of castings for high-pressure work may lead to leaking or weeping when under pressure. Some melters prefer aluminium for this final degasification; others rely upon titanium. On the whole, the bulk of the evidence points to ferro-titanium giving the best results, although its use is more expensive. Aluminium is practically instantaneous in its action, whilst titanium gives its best results only when the metal is allowed to stand from 3 to 5 minutes in the ladle before pouring. When this is done, there is definitely a greater freedom from inclusions.

Contaminated Scrap.

Before leaving the question of melting practice there is one other point which ought to be mentioned, *i.e.*, the scrap position. With the growing use of alloy steels and irons, a larger and larger tonnage of these metals containing alloying elements, such as chromium, nickel, copper, etc., is being sold. Sooner or later some of this finds its way back to the scrap bin, and, whilst very welcome to the maker of alloy steels, these alloying elements present some very unpleasant problems to the maker of plain carbon steels for castings. In some cases they affect to some extent the reactions in the furnace; in others, the casting properties of the steel, and in others again the heat treatment, is affected. The day will soon arrive when steel founders will be compelled, in their own interests, to form specifications for scrap, and it may even be more profitable to pay an extra few shillings per ton if the composition of the scrap is known and guaranteed.

(To be continued.)

The Perran Foundry.

The important part played by the Perran Foundry in the pioneer century from 1750 to 1850, when Cornwall was one of the principal centres of mining and engineering activity in the world, constitutes the subject of an interesting and informative article in the 96th annual report of the Royal Cornwall Polytechnic Society, issued recently. The author, Mr. W. Tregoning Hooper, says that in the early nineteenth century, the mechanics from Perran often submitted models, inventions, or proposed improvements in the construction and methods of manufacture of steam engines to Mr. Robert Were Fox, of Falmouth, for his opinion. The ingenuity and keenness of these men so impressed Miss Anna Maria Fox that she proposed that a society should be formed to encourage and assist such men to study the sciences connected with their work. Miss Fox's suggestion was well supported by her father (Mr. R. W. Fox) and members of the family, and, with the assistance of Sir Charles Lemon and many others, the Cornwall Polytechnic Society was formed, which a few years later received Royal patronage and its present title. This society, therefore, may not unfairly be said to owe its origin to Perran Foundry. Mr. Hooper goes on to say that the great improvements by Messrs. Boulton & Watt in the steam engine made it possible to develop the Cornish mines on a larger and deeper scale, and in 1791 the Fox firm decided to establish a foundry capable of supplying all the machinery required by Gwennap mines, the site chosen being in the vale of Perranarworthal, at the head of a branch of Falmouth Harbour. "Davies Gilbert, writing in 1835, refers to Perran Foundry as being the first of any magnitude in the county, and that cylinders of 90 in. dia. were cast and bored with the utmost degree of accuracy. In 1815 a large beam was cast for Trevithick's famous 76-in. pumping-engine, which was erected at Dolcoath by the engineers, Jefferies and Gribble. The beam in question weighed from 25 to 30 tons. It continued to work until 1867, when it was replaced by a new engine, but the old beam was again utilised, and remained in use until recently. This beam and engine are referred to in Burrow's 'Mongst Mines and Miners' as one of the objects which remind one of the remarkable antiquity of Dolcoath mine." The foundry enjoyed a world-wide reputation for the excellence of its products, which consisted mainly of mining machinery, and among the principal engines made there, he mentions Taylor's 85-in. for the United Mines (1840); Haarlem Lake, Holland, 144-in. and 84-in.; Harris Navigation Colliery, 100-in.; a 144-in. blowing engine for Ebbw Vale Steel Works; Wheal Busy, 90-in.; and four large engines for the Burra Burra mines. He also mentions that the steel or iron work for the Lizard Lights building was all prepared at Perran Foundry and erected by the firm. The foundry could likewise claim an early acquaintance with the marine engine, as it was reported in a newspaper, dated April 5, 1832, that the "Firebrand Steam Packet" was to proceed to Malta that day after having been repaired by workmen of Messrs. Fox & Company, of Perranwharf, but little marine work was undertaken until 1866. Four or five steamers were then engined for Captain Philip Thomas, of Falmouth, among them being two well-known vessels, the "Prairie Bird" and the "Rapide," while several yachts were engined and a very fast launch for the Thames Water Police. The manufacture of mining implements was also an important part of the work done at the foundry, especially shovels. The demand for shovels necessitated night shifts being worked for long periods in order that shovel making could proceed without interfering with the foundry's normal activities. Wide as the firm's reputation was, says Mr. Hooper, the great mainstay was the Cornish mines, and when the Gwennap mines ceased work it soon became obvious that Perran would also have to cease operations. The end was hastened by the death of Mr. Shilson, and the failure of Tweedy's Bank. In 1879 the works were closed, the machinery sold or broken up, and a company of efficient workmen were scattered all over England to enrich younger concerns with their skill and experience.

Steel and Rail Cartels.

A report has been current in Brussels to the effect that negotiations are impending for the inclusion of British makers in the Continental Steel Cartel and the fixing of minimum prices. In certain well-informed German circles the report is characterised as a "feeler," while in some other quarters it is said to be devoid of any foundation. It is added that no negotiations have taken place with British interests for over a year, and that there is no prospect whatever of a resumption of the preliminary discussions within the near future. It is again emphasised that the British steel industry has no interest in joining any international steel-ingot combine, and that such a contingency would only arise on the establishment of firm international selling syndicates for different products; it is only in such a case that the participation of Great Britain could be seriously discussed.

Within the Managing Committee of the Continental Steel Cartel negotiations are still proceeding concerning the formation of a new basis for the Cartel. Some four schemes are under consideration, but all these show in part divergent tendencies, so that at present it is impossible to foresee in what form the new Cartel will be established. Discussions of these schemes took place at a meeting in Liége last Tuesday (December 3), but any serious consideration of the question of selling syndicates will scarcely be possible just yet. As to fixing prices by means of loose agreements among the different groups without the formation of selling syndicates, it is submitted that such arrangements would be doomed to failure owing to the policy of outsiders, both in Belgium and Germany, while at the same time Poland and Great Britain also continue to remain independent. In the circumstances it would be impossible, under loose price agreements, to undertake any aggressive methods against outside competitors.

It is stated that the other members of the International Rail Makers' Association (Irma) are devoting attention to the fact that an agreement has been entered into between Argentina and Great Britain for the delivery of about 120,000 tons of railway material, and that Argentina has undertaken to obtain all her rail requirements from this country. The other members assume that the British quota in the Association will soon be exhausted and that the orders still expected from the Dominions and the Colonies will cause the quota to be quickly exceeded. It is reported from Brussels that the Belgian and Luxemburg group in the Association have protested against any increase in the quota of any individual member.

New Companies.

Richard Melhuish (London), Limited, 50, Fetter Lane, London, E.C.—Capital £5,000. Ironmongers and founders, etc. Director: H. Kelly.

Albutt Sons & Jackson, Limited, Hope Street, Halifax.—Capital £2,500. Brass founders, etc. Directors: T. H. Albutt and T. R. Jackson.

Rustless Metals, Limited.—Capital £2,000. Directors: A. D. Sturrock (chairman), 15, Ollerbarrow Road, Hale, Cheshire; R. F. Jackson and F. A. Rennison.

John W. Wilson (Stoves), Limited.—Capital, £5,000. Ironfounders, etc. Directors: J. W. Wilson, Raisen Hall, Herries Road, Sheffield; H. Cropper and J. T. Ellis.

Messrs. Dorman, Long & Company, Limited, have received an order for 5,000 tons of steel sleepers for renewals to the main lines on the Rhodesian railways. A similar order has been placed with Messrs. Guest, Keen & Nettlefolds, Limited, while an order for 6,000 tons of steel sleepers has been placed with the Barrow Hematite Steel Company, Limited.

Sand Preparation and its Relation to Continuous Moulding.*

By J. B. Corrie.

The scientific treatment of moulding sand has in the past been sadly neglected, and in 90 per cent. of the foundries in Great Britain one encounters an apology for a sand plant, tucked away in some remote corner of the foundry, placed there, one can only conclude, because the proprietors are ashamed to put in a more prominent position. It consists of an edge-runner, possibly a mechanical sieve, and improbably an aerator.

The sand is laboriously man-handled, the mixture is left to the tender mercies of labourers, and where an aerator is used, it throws out the sand on to the foundry floor, where it promptly gets contaminated with dirt and floor sand.

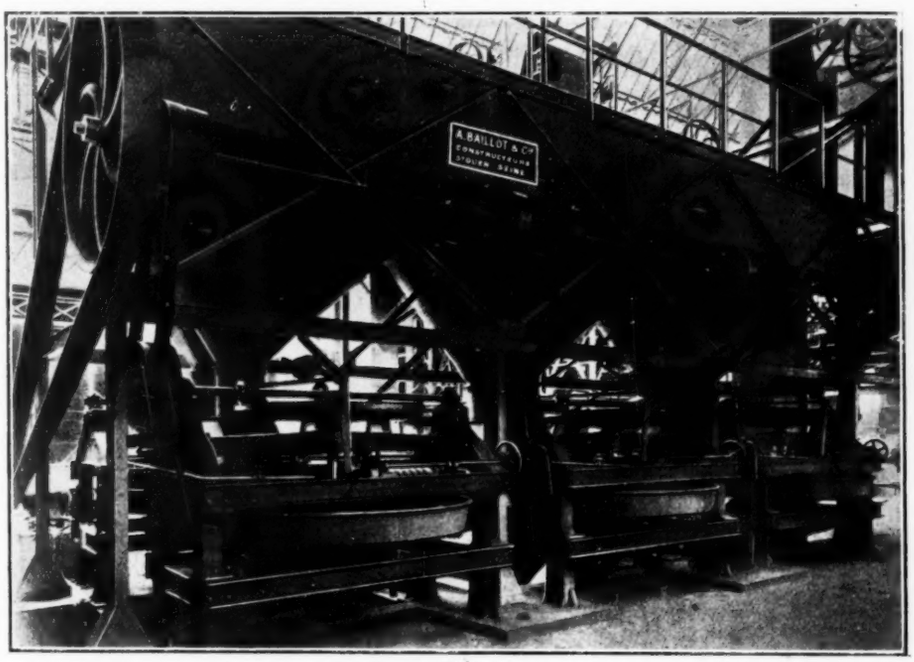


FIG. 1 ILLUSTRATES THE SEMI-PREPARED SAND STORAGE HOPPERS AND PAN MILLS OF A SIX-PAN PLANT. CAPACITY APPROXIMATELY 20 TONS PER HOUR. NOTE THE WATER SPRAY PIPES FOR ADDING THE WATER IN THE PAN MILLS. THE HAND WHEELS OF THE RIGHT OF EACH PAN OPERATE THE DISCHARGE SCRAPER FOR DISCHARGING THE SAND THROUGH THE CENTRE OF THE PANS.

On the Continent, however, particularly in France and Belgium, and notwithstanding the fact that these countries possess the finest quality of moulding sand in the world, the treatment of sand is considered of primary importance, and it is realised that the best results can only be consistently obtained by thoroughly cleaning, mixing, re-inforcing and aerating moulding sand.

In many foundries in England huge heaps of floor sand are turned out of the foundries, the great bulk of which could be reclaimed and used over and over again if a plant was installed capable of cleaning and reinforcing it. In such foundries it is generally found that the new sand employed is as much as 30 per cent., and the sand bill in large foundries assumes a formidable annual expenditure.

Basic Properties.

Dealing first with the primary essentials of a good moulding sand, it is generally understood that it should be sufficiently refractory to withstand the temperature of molten iron (say, from 1,300 to 1,450 deg. C.) without fusing. It must be sufficiently porous to permit the gases to escape readily. The air in the mould space, and the gases formed by contact of the molten iron with the coal-dust and other organic matter, also the moisture contained in the sand, are expanded considerably.

In the case of water, this expansion amounts to many times its original volume and unless artificial, or natural means, are provided for escape, boiling will occur at the face of the mould and the quality of the casting will be affected. Moulding sand must be cohesive enough to retain any moulding shape imparted to it by the pattern and to resist the wash of the molten metal when the mould is being filled. The sand must be sufficiently plastic to reproduce readily the contour of the pattern. It must be sufficiently adhesive to enable it to adhere to the flasks or boxes. Alkalies, such as salts of sodium, potassium; bases, such as calcium, magnesium and ferrous oxide, FeO, reduce the refractory qualities of sand, increasing the tendency of the sand to fuse through combination with the silica and hydrated silicate of aluminium present. The latter, with ferric oxide (Fe_2O_3) and hydrated ferric oxide ($Fe_2O_3\ 3H_2O$), form the bonding material for the silica grains. The coal-dust present reduces the oxides to FeO at the temperature of the metal, which also drives off the combined water from the hydrated silicate of alumina, hence additions of new sand are requisite to replace the destroyed bonding materials. The proportions of new sand and coal-dust vary according to the type of casting, and it is possible to reduce the amounts added to the floor sand by thorough and efficient mixing in such a manner as to distribute the new sand and coal-dust equally throughout the mass.

Inefficient mixing is shown by the sand having a mottled appearance, due to patches of new sand in a black matrix. The wetter the sand the more difficult the mixing, and to ensure that all parts receive an increment of new sand and coal-dust the mixing must be made dry. If the new sand is wet a great deal of waste occurs when riddling, or sieving the sand, the riddlings being excessive and consisting largely of spots of new sand instead of a homogeneous mass. Promiscuous watering of sand on the floor of the foundry should on no account be tolerated. The requisite amount of moisture should only be added in the pan mill and a pipe line with spray should be provided for the purpose.

To sum up this brief survey, the following are the essentials of a good moulding sand:—(1) Refractoriness, (2) porosity, (3) plasticity, (4) cohesiveness and (5) adhesiveness. All these can only be obtained by proper mixing of the new sand, (1), (2) and (3) mainly by uniformity of mixture, (4) by ensuring distribution of the bond, and (5) by ensuring thorough distribution of the moisture. The old method, still practised in many works, is to lay out the materials in alternate layers, afterwards cutting slices vertically and riddling by hand or mechanical means, the product being known and used as facing sand.

Translation in Practice.

The primary desideratum of any sand-mixing plant to give the above results is to combine all the elements into one unit, that is to say, a modern sand-mixing plant should consist of the following:—(1) An efficient means of regulating the mixture found by trial to be most suitable for the particular type of casting to be produced: (2) the plant should include a sand mill or mills, sieve, magnetic separator, aerator, sometimes termed a revivifier, where continuous moulding is in use, a special sand cooler, and ample storage accommodation in the shape of overhead hoppers for the semi-finished and finished sand; (3) the plant should be designed so that the foundry foreman, having determined the most suitable mixture of sand, can readily adjust and set the feeding hoppers accordingly. Under these ideal and essential conditions it is only necessary for the feeding hoppers to be kept supplied with floor sand, new sand and coal-dust. The machine should do the rest and produce continuously a uniformly good quality and mixture of moulding sand; (4) the plant should employ a minimum number of operators, and for this purpose it should be as nearly automatic as is practicable, and (5) provision should be made for supplying the necessary amount of moisture in the sand mill or mills.

The sand should be passed through the sand plant in as dry a condition as possible, for the very definite reason that *sand cannot be properly mixed in a wet state*, and if wet will coagulate in the sieve and block up the holes therein. If the new sand is wet it should be thoroughly dried before use and afterwards milled by very light rollers and passed through a fine-gauge rotary sieve of about 29 mesh to the inch. In such a plant the amount of new sand employed should never exceed 10 per cent., and should be very much less after the existing floor sand has been treated and reinforced a few times in the sand plant.

Continental Practice.

On the Continent the following is a representative mixture for light castings where a semi-automatic sand plant of the Alfred Baillot type is employed:—New sand, 0.5 to 5; coal-dust, 0.2; water added in pan, 2; probable moisture in floor sand before treatment, 5, and floor sand, 87.8 to 92.3 per cent.

The proportion of new sand varies according to the nature of the castings and the quality of the new sand. The thicker the casting the higher the proportion of new sand. The percentage of coal-dust also varies according to the casting to be produced. The author has recently seen the results of experiments carried out by

* A Paper read before the Falkirk Section of the Institute of British Foundrymen. Mr. R. Ure presiding.

a well-known firm making light castings about $\frac{1}{8}$ in. in thickness, and they have found that they obtain the best skin finish with a moisture content of 3.5 per cent.

For machine-moulding, facing sand should, whenever possible, be dispensed with and one uniform quality of sand used for facing and backing. For machine-moulding average-weight castings the total amount of moisture in the finished sand, to give the best results, should be 7 to 8 per cent. With sand of a good quality this percentage will afford the necessary bond and the sand will be sufficiently dry to enable it under pressure to flow around the pattern. In this connection it is interesting to note that in the works of Société Fonderies et Emailleries at Noyon one quality sand only is used in the manufacture of cast-iron baths. The output of this foundry is 100 to 120 baths per day, and the sand plant, which is of the six-pan mill type, has an output of 20.5 tons of sand per hour. The total number of men employed on the sand plant and sand distribution is five.

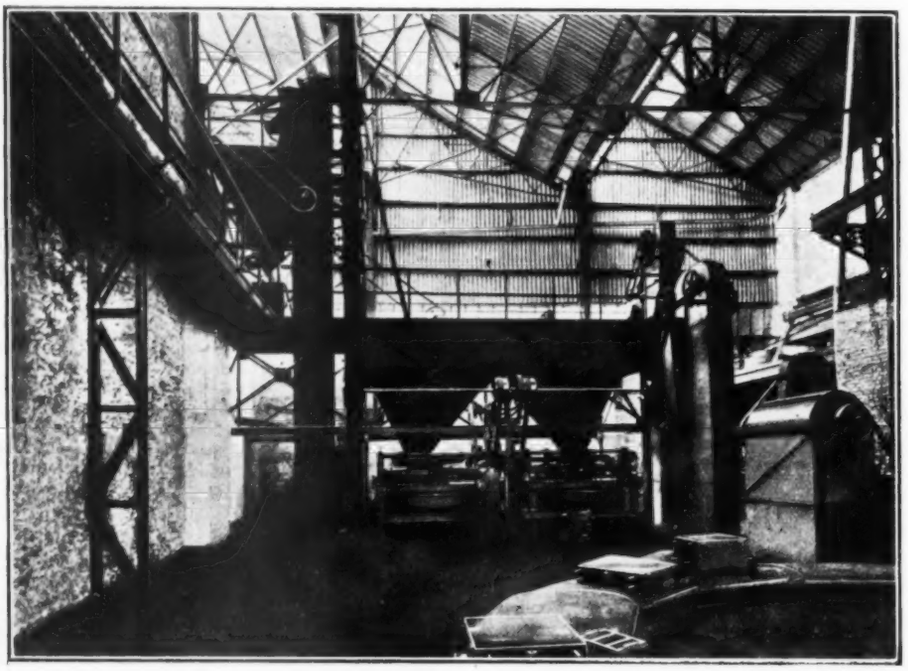


Fig. 2 shows a complete Four-pan Sand Plant, capacity approximately 12 tons per hour. This plant is arranged for overhead distribution of sand by means of conveyor belt. On the right is a small new sand-drying and preparing plant, and in the foreground a continuous moulding table.

Cooking-Pot Castings.

A plant which was put down in France for the manufacture of cooking-pots proved so successful that the whole plant is being moved to Belgium, where a most modern foundry is in process of erection, on the same continuous system, for an output of 8,000 to 10,000 castings per day of an average weight of from 5 to 6 lbs. each. The sand plant has eight sand mills with an output of 274 tons of finished sand per day. The number of labourers employed on the sand plant and for sand distribution is six. The amount of new sand used is barely 1 per cent., which corresponds with the amount of sand discarded. The foundry floor is built over a cellar 7 ft. deep, in which are arranged the continuous return-sand conveyor belts. The moulding machines, which are of the hydraulic squeeze type, are served with sand by conical steel hoppers, fed by continuous overhead conveyor belts direct from the sand plant.

The moulding boxes are knocked out over grids and the sand falls on to the underground conveyor belts, already referred to, together with the "spill over" sand from the moulding machines, all of which is thus automatically conveyed back to the sand plant for re-treatment.

Mixing Details.

An automatic new sand dryer has been installed. This consists of a small furnace, burning anthracite or coke, above which is mounted an electrically-driven fan which blows hot air through the dryer. The latter consists of a number of circular cast-iron boxes, mounted one on top of the other. At the top and bottom of each cast-iron box is a long narrow hole, each hole being "staggered." A steel shaft passes through the centre of the dryer and is very slowly rotated by bevel gearing. To this shaft are secured steel scrapers, one to each box. The wet sand is shovelled by hand into the hopper of a distributor and is elevated to the top of the dryer by means of a bucket elevator. The sand falls into the first cast-iron box and remains there until the scraper sweeps it down the hole in the bottom into the next box, and so on. On reaching the bottom of the dryer the sand is perfectly dry and is discharged intermittently on to the floor, or preferably into a bucket.

The dried sand is then milled in a fixed pan by very light-weight rollers, from which it is passed into a bucket elevator which discharges it into a fine-mesh rotary sieve of about 29 mesh to the inch. From there the finely sifted new sand is delivered through a distributor on to a conveyor belt on which is also being discharged the floor sand and coal-dust, the mixture being conveyed to the semi-automatic sand plant. The required mixture of floor sand, new sand and coal-dust is made in three hoppers called automatic distributors. At the bottom of each hopper a circular adjustable steel sleeve is provided, and under each hopper is a circular steel plate, slightly eccentric to the orifice of the hopper, revolved by worm gearing. The new-sand and coal-dust hoppers discharge their contents on to their respective revolving discs, and these in turn discharge on to the revolving disc of the floor-sand hopper. The sleeves being capable of vertical adjustment, it follows that by regulating the distance between the sleeves and the revolving discs, the discharge of the floor sand, new sand and coal-dust can be so regulated as to give any required mixture.

The floor-sand distributor delivers the mixture into the bottom of a bucket elevator, which elevates the mixture to the top of the plant and passes it over a magnetic separator which extracts all particles of iron. This description refers to the usual distributor system, but in some cases the arrangement is different and each distributor discharges its contents on to a conveyor-belt leading to the sand-plant elevator.

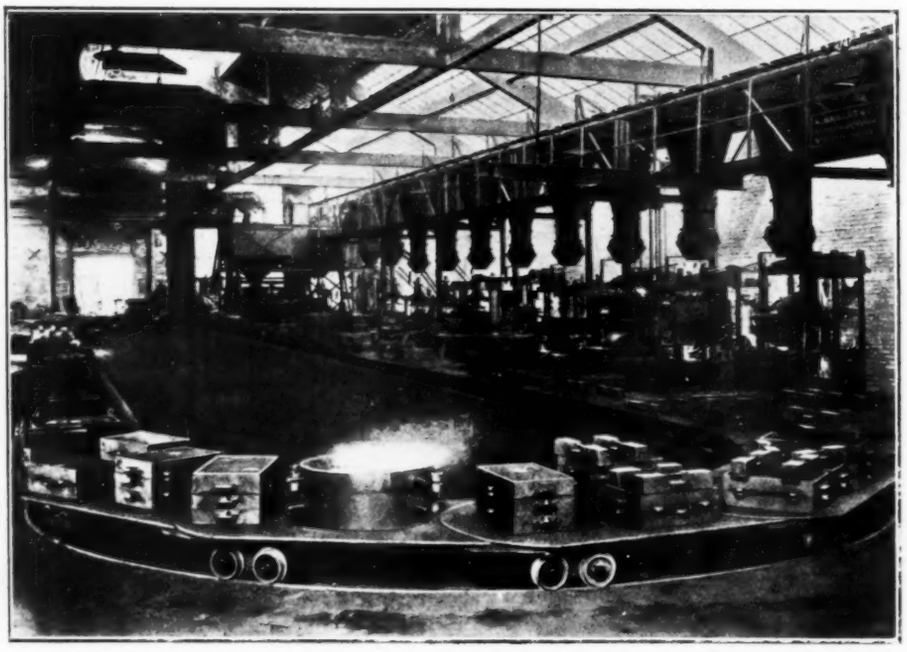


Fig. 3 illustrates a complete Continuous Foundry, comprising sand plant (in back ground), overhead sand distribution to moulding machines, underground sand return to sand plant, and continuous conveying table.

(*Continued on page* 412.)

Hints on Non-Ferrous Foundry Practice.

LONDON DISCUSSION HELPFUL TO PRACTICAL MEN.

Following Mr. J. McNeil's Paper on "The Founding of Some High Melting-point Non-ferrous Alloys,* given to the London Branch of the Institute of British Foundrymen, an enlightening discussion ensued. The chairman (Mr. J. W. Gardom) asked Mr. H. C. Dews to open the discussion.

Mr. Dews said he considered that all the author had said was so thoroughly sound that there could be no question about the great value of his lecture. The section on de-oxidation and the effect of impurities on nickel was particularly interesting. The effect of small amounts of impurities and the question of de-oxidation with nickel alloys more than with other alloys governed the soundness of the castings which were made.

Influence of Magnesium.

The author had referred to magnesium, but the present speaker could not say that his own experience of the use of magnesium had been particularly happy. The author told them that the best way to add magnesium was to tie a piece at the end of an iron rod and plunge it down into the pot of molten metal, but he himself had found that in this practice the magnesium immediately melted, rose to the surface of the metal, and practically entirely burnt away, leaving on the surface a thick scum of magnesium oxide which became entangled in the nickel alloy. This resulted in nasty patches of magnesium oxide in the castings. Moreover, he could not be sure that if he did get magnesium in the nickel alloys it was doing any good.

Sulphur in Nickel Alloys.

This brought forward the question of sulphur in nickel alloys. There had been a good deal of reference in technical literature to the effect of sulphur in these alloys, but so far he had not been able to trace any data which threw any real illumination on the effect of the sulphur on the quality of the castings, and he wondered whether sulphur was, after all, quite so important as some of these published researches would lead one to suppose.

Effect of Other Elements Not Well Defined.

With regard to the use of manganese and silicon, the author apparently was more in favour of the use of the former than of the latter. Could he say definitely that silicon acted in the same way as manganese in nickel alloys? One great advantage with silicon was that one was liable to get silica forming an unpleasant white scum, which might be found in the castings if great precautions were not taken.

The author had also stated that the silicon improved the fluidity of the nickel alloys, while magnesium decreased the fluidity. But he himself wondered whether magnesium did decrease the fluidity, or whether the effect was not brought about because the magnesium oxide became entangled in the metal.

Liquid Shrinkage Defined.

He wanted to join issue with the author on one point, namely, the use of the term "liquid shrinkage." He did not think it was quite right to define liquid shrinkage as the shrinkage which took place while a metal was passing from the liquid to the solid state. The term "liquid shrinkage" should be reserved for shrinkage of the liquid only, and it would clarify the position if technicians would give a lead in this respect, and would use some such term as "solidification contraction," or "solidification shrinkage" in the other instance.

Mr. A. E. Perry said that he had occasionally experienced trouble with regard to runners and risers, and as a result it was his normal practice to run castings as nearly as possible with a series of small runners into feeding heads. In this way hot metal is placed in the best position for feeding the casting. Looking at some of the photographs which had been shown that evening, it had occurred to him that possibly it might be better to have more risers. He asked the author whether fifty-fifty was quite sufficient. As far as the sand for moulding was concerned, he had found it very successful to use 50 per cent. of Mansfield sand and 50 per cent. of silica sand for both dry and green moulds. In that way a good face was obtained.

Oil-Firing Eulogised.

Mr. G. L. Cassidy said that the lecturer had referred several times to the use of manganese as an addition at the end of the melt, and in one case he had spoken of the charging of the manganese initially. He wondered whether this seriously cut the crucible, and whether silicon was better as a deoxidiser from this point of view. The author had also referred to the use of coke and electric furnaces for melting these metals, but he had left out the oil furnace, which was really ideal for high-temperature metals. In one or two installations with which the speaker was familiar even pure nickel could be melted straight from nickel shot and made into castings weighing up to 10 cwts. He would like to have the lecturer's opinion on oil-firing for high-temperature metals.

Mr. H. Cowan (B.C.I.R.A. Lab., Falkirk) desired to ask the author three questions, one dealing with the metal, one with the sand, and the third with the fuel. In the early part of the Paper the author gave a scale of results in connection with the effect of casting conditions on the mechanical properties of nickel-silver. Could he give any reason for the considerable reduction in mechanical properties as a consequence of a comparatively slight reduction in the casting temperature? The author had further stated that the sand, the name of which he gave, furnished quite a good surface to the casting. The speaker wanted to know what sort of surface on a casting was obtained if such a sand was not obtainable. If the only sand available was not considered by him to be good for the purpose, could he suggest any means of treating the sand to give a good surface? His third question related to fuel. The author had referred to coke, and in one instance had mentioned beehive coke. Was it his experience that beehive coke was any better than patent-oven coke?

Mr. J. D. Hotchkis said that some time ago his firm was doing case-hardening, and tried the use of cast-iron pots. The first time these were in the muffle one of them burnt through. They became oxidised and came away in scales; but the nickel-chromium pots would last a lifetime. What effect would the melting of aluminium in a nickel-chromium pot have? Would it affect the aluminium in any way?

Mr. G. C. Pierce said that there were just a couple of points on which he would like information from the author. Would the author indicate which were proprietary alloys out of those he had spoken about that evening? Again, did he not have trouble in raising the iron content of his alloys by using an iron poker? It seemed that there was a possibility there of raising the iron content. Was the author's experience in using carborundum crucibles such as to make him advocate their use in preference to the graphite crucibles, in view of the friable nature of such crucibles? Would the author inform the meeting as to what caused the runner heads of some of the higher nickel alloys to grow during solidification and assume a cauliflower appearance and often force the metal out of the mould?

Author's Reply.

Mr. J. McNeil, in reply, after thanking the various speakers for their kind remarks on his Paper, gave a detailed reply to the points raised.

Mr. Dews had asked about the addition of magnesium. On the addition of magnesium to high nickel-content alloys, a thickening did certainly take place, but he did not consider that this was due to the retention of magnesium oxide actually in the melt. When the alloy was thoroughly treated with magnesium, one found on skimming that there was an appearance as if flakes were rising to the surface of the metal, which was more or less an indication that the metal was thoroughly treated. If, however, a section of an alloy such as Monel metal was examined microscopically, he did not think that magnesium oxide would be found in the material to any extent.

Sulphur causes Brittleness.

The deleterious effect of the presence of sulphide is most marked in remelted metal. If one were to continue remelting in coke-fired furnaces without taking precautions to keep down the sulphur content, the combined effect of the small increases of sulphur would be emphasised, showing more clearly the tendency to make the alloys distinctly brittle.

As for the rising of magnesium to the surface and burning away, if it was added either in the form of $\frac{3}{8}$ in. or 1 in. dia. rod, and in the manner already suggested, it would do all the work with very little loss. An extremely small amount of magnesium is sufficient to give a considerable flare on burning on the surface.

With regard to the choice of manganese or silicon as a deoxidiser, he had not intended to infer that he preferred the manganese. Actually his personal opinion was that silicon was the more efficient deoxidiser. It also had the effect of raising the temperature of the melt when added and made the metal more fluid, which was again to the good.

Referring to the term "liquid shrinkage," he could not quite agree with Mr. Dews, because it was felt that the chief shrinkage took place actually when the metal was passing from the liquid to the solid state. The term "solidification shrinkage" might be used, but then this would simply add a third term to describe the reduction of volume on cooling.

Numerous Small Gates Effective.

Mr. Perry had mentioned the size of heads and gates used in nickel alloy castings. It was rather difficult to answer this question definitely, but it was thought that his proportion of fifty-fifty—that is to say, 50 per cent. for heads and 50 per cent. for castings—would approach pretty closely to what would be required, but this, of course, would depend on the nature of the casting and the number and dimensions of the heads used. It also varied with the composition. In the casting of nickel-chromium alloys it had been found that in many cases small gates and plenty of them gave the best results. In the casting of nickel-copper, the general experience was the advisability of having large gates and risers for solidity.

Mr. Cassidy had mentioned the question of the addition of manganese oxide or manganese ore at the beginning of the charge. As far as the speaker knew, there was no deterioration of the crucible which could be directly put down to the effect of that addition. So far he had never come across any instance of that. The main attack on the crucible was found, if anywhere, around the slag line, and that was got without any manganese-oxide additions at all.

With regard to oil-fired furnaces for nickel alloys, he had not mentioned these in detail, but

* Published in our issue of November 28, page 385.

had only referred to their use among others. As Mr. Cassidy had said, the oil-fired furnaces could be used with success equal to that of the coke-fired furnaces, and they were being used in one case of which he was aware with melting periods the same as with good coke-fired furnaces. The sulphur content of the oil, however, had to be controlled. It should also be low.

Mr. Cowan had mentioned the effect of the casting temperature on "nickel-silvers." No particular reason could be given for the sharp reduction in strength for a difference in casting temperature of about 60 deg. C. apart from the variation of crystal structure. Such reductions certainly did take place, and it was an important factor in the making of "nickel-silver" alloy castings that the casting temperature should be within good control.

With regard to the sands used for nickel-chromium alloys, if a poor quality was used the necessary rapid escape of air and gases from the mould would not be obtained, this being essential with high-melting-point alloys. Apart from this there would be a liability of the fusion of the sand to the metal, resulting in a hideous surface on the finished casting, unless precautions were taken to have suitable facings.

As for the difference in quality of Beehive and by-product cokes, both of these were of a hard nature. He mentioned the use of Beehive coke as it was known that this quality was employed in this connection and gave good results, but he did not see any reason why the by-product coke should not be used also.

Pencil Runners or Drop Gates.

Mr. Hotchkis had mentioned the question of pencil runners for "nickel-silvers." In Mr. Ronceray's system the running was adjusted so that the metal practically set as the mould filled. He agreed that it might be possible to use pencil runners in some instances, but, of course, this could not always be applied in the case of "nickel-silvers," this system being chiefly adopted for drop gates.

Comparing the life of nickel-chromium carburising pots with cast-iron pots, the former gave greatly increased life, something like twenty-five times as great. This more than covers the extra cost of the nickel-chromium pots. Regarding the effect of aluminium, no definite statement could be made in this connection.

Mr. Pierce had asked which of the alloys mentioned in the Paper were proprietary alloys. The particular alloys which had been mentioned were all proprietary alloys, but they were simply taken as examples of the various series, the names being used as a means of identifying them.

Regarding the contamination by iron from the rod used in adding magnesium, it was considered that, as this was only in the metal for a few seconds, very little iron would come from this source. It is, however, advisable not to use iron rods for prolonged stirring.

With regard to the "cauliflower" tops which had been referred to, this was some indication in the case of Monel metal that the metal had been properly treated. No specific reason could be given for this particular formation.

Vote of Thanks.

Mr. Faulkner proposed a very hearty vote of thanks to Mr. McNeil for his Paper, which, he said, had been of an unusually practical character, and would be utilised as a work of reference for a long time to come. Mr. Summers seconded, and Mr. McNeil suitably acknowledged.

British firms received 83 per cent. of the contracts placed by the India Stores Department in London during 1928-29, according to an official report published in India.

Institute of British Foundrymen.

THE EAST MIDLANDS BRANCH.

A large number of members of the East Midlands Branch of the Institute of British Foundrymen attended the meeting, held at Loughborough, on November 23. Preceding the meeting, over which Mr. J. Lucas presided, members from Derby, Leicester, Nottingham, Newark, Syston and Loughborough were conducted over the college, which has been provided with a well-equipped foundry for the benefit of the foundry students. Everything in detail was interestingly explained by the Principal, Dr. H. Schofield, who was accorded a vote of thanks.

At the subsequent meeting, when a welcome was offered to Mr. A. Sutcliffe, of Bolton, Mr. J. Lucas referred to the progress of the branch and commented on its growth during recent years. They were doing much propaganda work and had specially riveted their attention on Nottingham, which had so few members. There was no reason why Nottingham should not have one of the largest memberships of any town covered by the branch. However, Mr. Stevenson, one of the Nottingham members, who was a past President, had spent considerable time with Mr. Makemson, the General Secretary, in interviewing foundrymen and managers who were eligible to become members, and he was hoping that before the end of the year there would be an influx of Nottingham foundrymen wishing to join. The Council had arranged to hold a meeting at the Nottingham University College on December 14, and an open invitation was extended to all foundrymen. He was glad that fresh applications for membership had been received, and these were now being dealt with by Mr. H. Bunting (Secretary).

Mr. A. Sutcliffe, who spoke on the work in a jobbing foundry, and specially dealt with the production of pipes, rope pulleys and hydraulic cylinders, declared that it was of no use making a casting if it could not be sold. Mr. Sutcliffe, who exhibited a number of lantern slides to illustrate his various arguments, dealt with questions concerning his own personal experience at his works in Bolton. One of the most important matters to which foundrymen were paying attention at the present time was the production of elbow pipes. He had made one only the previous day, and thought it was quite a good job. They did not want pipes with acute corners. In a reference to various castings, he declared that he had always found it advisable to leave sufficient head on them in case there was any blowing, as this would take place in the head without affecting the casting and the head could be severed. He personally had been concerned in some rather big jobs, and although he had been handicapped for room he had always found a solution. His pit was only 10 ft. deep, while there was only 12 ft. of head room.

Mr. S. H. Russell said he had always had a great admiration for Mr. Sutcliffe, who did many things in his foundry that he (Mr. Russell) would hardly dare to attempt. Handicapped as Mr. Sutcliffe was, he thought that in many cases he was asked to attempt things he should not be asked to do. He had been rather struck by the method adopted by Mr. Sutcliffe in his production of pipes with an elbow bend. Personally, he would have found a cheap pattern to do the job rather than emulate the example illustrated on the screen. He was not altogether in agreement that the porosity of the ram they had seen would have been cured by a bigger head. Porosity and dirt were two different things. Porosity was formed in the ram after it had cooled, usually in the thickest part of the casting. If using a suitable iron, he thought porosity would eventually clear. He greatly admired the very frank way in which Mr. Sutcliffe had spoken to them, and also for the photographs of foundry jobs which he had done.

Mr. Sutcliffe said it was all risk for the foremen moulders to-day. The elbow pipes to which he had previously referred had been produced at his foundry; he thought the method adopted was satisfactory in the case of an old foundry. "My foundry is definitely old," he said, "and I have cupolas over 100 years old." (Laughter.) If they were working in a jobbing shop and the foreman pattern-maker had been there for years, and the manager, too, was old, it was very hard to get any alterations. Although core irons were used, it was in his opinion quite a simple matter to produce the elbow pipes.

In reply to a member, Mr. Sutcliffe said that pipes with elbow bends were more suitable. Pipes with acute angles were out of date. When either steam or water was being passed through an elbow-bended pipe it would flow much easier than through a pipe with an acute bend.

Mr. J. F. Driver, in proposing a vote of thanks to Mr. Sutcliffe, said he had been particularly interested. The point that had interested him most was the production of the elbow pipe to get steam and water to flow more easily. It was quite feasible that pipes so designed would have a lesser tendency to collect any dirt.

Mr. Smith, in seconding, said they had learned a lot of what could be done in an old jobbing foundry. Sometimes their managers told them that certain things could not be done, but after hearing how Mr. Sutcliffe could produce castings under difficult conditions they were now convinced there were always two sides to a question.

Mr. Sutcliffe, in reply, said if they had learned anything he was glad, as it had been a pleasure to speak to the foundrymen of the East Midlands. With regard to porosity, he would again declare that if they allowed for more head they need not worry. The head would not be wasted.

Mysore Iron Trade.

Future of the Bhadravati Works.

The Mysore Government propose to appoint an expert committee to investigate the present position of the Bhadravati Ironworks and its future prospects. In the discussion of the motion in the State Assembly it was remarked that the venture was a white elephant which had so far resulted in a loss of Rs. 90 lakhs (£675,000). The proposal was made that the concern should be converted into a joint-stock company. On behalf of the Government, it was replied that the present unfavourable position was due to depression in the iron market, where the prices per ton had dwindled to a third of what they were before. In the opinion of the Government, the works had a bright future.

The report of the working of the concern for the year 1928-29 shows that the blast furnace was enlarged to a rated capacity of 80 tons, and blown in for operation in September, 1928. The plant was thus in operation for less than ten months during the year, and the output amounted to 18,500 tons, or a daily average of 63 tons, against an average of 55 tons, the highest yield in any year previous to the enlargement. The increased output of pig-iron, helped by the high prices obtaining for acetate of lime, the principal by-product, tended to reduce considerably the unit cost of pig-iron below the level attained in previous years. The competition of the Northern Iron Combine has reduced the selling rate of pig-iron in Southern India even below the ruling market rates in the north, and it was with considerable difficulty that the works were able to secure this year orders for pig-iron from the railway workshops situated within favourable distance of Bhadravati.

The Mechanical Handling of Foundry Materials.*

By R. Spriggs.

Handling of Raw Materials.

The tendency to-day is to reduce raw material stocks to a minimum. The old idea of providing permanent insurance margins in stocks of pig, coke and limestone is wrong, as stocks should be liquid. The material should be used as it arrives. The founder must consider incoming sand, incoming pig, incoming coke and limestone. These materials have to be transferred from truck to store, and the means to be employed should be governed by the quantities to be handled. Much economy can be made in the arrangement of storage bins in their positions relative to siding cupola and mixing plant. Assuming the sand bins are adjacent to the railway siding, mechanical handling of sand from truck to bin will not pay unless one is receiving something approaching 100 tons per week. For medium quantities a small grab such as can be used in railway trucks is preferable, together with an overhead crane or transporter, especially if the grab can be substituted for a magnet and the latter used for unloading the pig.

One scheme for dealing with sand, coke and limestone was described and illustrated in THE FOUNDRY TRADE JOURNAL, Vol. 41, pages 225 and 242. Here the coke and limestone trucks were discharged by means of a wagon tippler into a large receiving hopper feeding a gravity bucket conveyor plant, which conveyed the material under a 50-ft. road, elevated it to the top of the building, and distributed it among the coke and limestone bunkers on the cupola stage. The sand is dealt with in a similar manner and by a similar conveyor scheme. Up to the present the wagon tippler for the sand has not been installed, but it has been provided for.

The cost of handling coke by hand methods is a serious item, especially if large stocks are kept. This problem was rather effectively met in one case recently by arranging the required supply to be delivered daily. This consisted of one truck. The coke was discharged by hand out of the truck, over a grid to take out the "fines," and fed automatically into a skip hoist. The skip hoist, electrically driven, discharged the coke on to the cupola stage in a handy position for charging into the cupola. The stage was large enough to take the daily supply, and the only handling was the raking out of the truck and charging into the cupola.

It is reasonable to ask why not a continuous bucket elevator? The ordinary bucket elevator tends to break the coke and cause too much fines. The only type of conveyor to do the job efficiently is the gravity bucket type, for which rather an elaborate feeding device is required which makes the scheme too costly for most jobs.

In the gravity bucket scheme referred to special steps were taken to prevent breakage. At the tippler, a timber apron was provided to receive the coke as it fell from the truck, so that it rolled along instead of dropping direct. It was then fed through a mesh feed by a large jigging plate into the buckets.

Where such an easy way of saving handling is impracticable, as in most cases, much can be done in the arrangement of coke, pig and limestone bins in such positions that charges can be made up on the floor with a minimum amount of handling and lifted straight up for discharge into the cupola.

A simple and efficient method of charging the cupola, which eliminates the need for a large stage, utilises a telpher system. This can be arranged to couple up to a crane to serve the yard, and a weighing machine can be inserted in the track; it can be arranged to handle a grab or alternatively a magnet.

The question of breaking pig is a frequent source of labour cost, but many foundrymen are proposing to overcome this difficulty in future by buying their pig broken.

Generally speaking, it is advisable to make up the charges on the floor and lift them direct to the cupola mouth, thus eliminating the cost of large and expensive cupola stages and the re-handling that takes place thereon. The author does not desire to be dogmatic on the point, because he has seen some large platforms put to very good use. In one case in the Midlands the platform was used to contain a reserve supply of charges in trucks. During the morning charges were made up and hoisted up to the platform. When there they could be easily pushed to the cupola and the charge put in. At certain periods the rate of charging greatly exceeded the speed of making up the charges, but by proper organisation and utilising the platform entirely for loaded trucks, continuity of work was assured, but in the case of a new foundry, the question of cutting out the large and costly stage, and making up all charges on the floor, is worthy of the closest consideration.

The progress made in conveyorising foundries is not as yet very great, but the signs at any rate are encouraging. Some years ago some firms tried conveyors and threw them out. To-day people who try them do not throw them out; they may alter their schemes and their layouts, but they retain the conveyors, and instead of scrapping them install more. It is a good plan to start experimenting with a length of gravity roller track. Several firms have done this, and in the majority of cases those firms have been able to devise important labour saving schemes from the very small beginning of a length of experimental gravity roller track.

Mechanising Moulding.

This presents a more difficult proposition. There is dry sand work to be considered, green sand work, facing sand, coring, the taking out of "fines," mixing and reconditioning, etc. Dry sand work is certainly difficult from the conveying standpoint, but one finds that founders are doing work to-day in green sand that they considered impossible to perform without baking a few years ago. Inquiry as to how this revolution has come about reveals that it is essentially one of choice of sand.

A well-designed conveyor system does tend to a better sand supply, a greater uniformity with better moulding properties. If there is provided a scheme which takes all the sand back through the mixing plant, where there is provision for exhausting the dust and for regular and uniform addition of new sand each time, where every time the sand is used it is screened, mixed, aerated, and automatically conveyed back to the moulders, the sand tends to improve and special facing sand becomes unnecessary, or, in other words, all the sand is equal to facing sand. A large ironfounder in Birmingham doing intricate work with such a sand system has been able to reduce his proportion of new sand to about 5 per cent., and the plant handles about 15 tons of sand per hour. Such a plant is not economical for small outputs. To be economical it should deal with not less than 10 tons of sand per hour.

A conveyor system to give full benefit should provide continuous sand to the moulders, it should take away the surplus or wipe-off sand; it should reduce the number of boxes in use; it should take the full boxes from the moulders; bring the empty ones back; the pouring should be at one point; the knock-out at one point, and should provide easy disposal of castings, runners, etc.

At the Stanton plant there is an output of 300 boxes per day, with only 30 boxes in use; there is no carting about of boxes, and the moulders are moulding at the machines all day. This, of course, is a simple job. It is a repetition job with no coring to do, and whilst in the bulk of cases such conditions would not apply, much can still be done with conveyors to increase output and reduce labour charges.

Where a wholly continuous plant is impossible, a semi-continuous plant will often give nearly as good results. In one lay-out for batch work, the moulds are poured in batches and knocked out in batches. Thus one must provide some reserve in the sand supply, so that the moulders may continue moulding when there is no knock-out sand coming through, and also provide accommodation for large batches of boxes until such time as they can be poured and knocked out. To assure this a conveyor placed alongside the moulding machine is of the power-driven roller type, having sufficient speed to take the output of all the machines without overcrowding. This feeds on to an ordinary gravity conveyor. The lines must be made long enough for the number of boxes that will accumulate until such time as they can be knocked out. The slope should be sufficiently deep for conveying entirely by gravity, so that the moulds will be pushed round in batches. It means a little labour in the pushing, but, on the other hand, there is no excessive bumping as might take place in a track where the moulds could freely travel by gravity.

An alternative scheme for batch production ensures a regular supply of sand to the moulders, the sand being reconditioned every time it is used, whilst the knock-out is close to the sand-mixing plant. The boxes are easily returned to the moulders by means of a further gravity roller track.

It is impossible to standardise such plants; every one requires carefully planning to suit local conditions and requirements. That is why it was stressed that much can be learned from experimenting with a few lengths of gravity roller track. Even the men themselves will at times work out dodges that improve production with these tracks.

Some roller conveyors are provided with a spacing device to prevent moulds bumping, one ingenious method being a double running board with spiral springs between the two boards, so that in the event of one running board bumping against another the mould merely swayed gently.

For average light work on moulding machines the ideal is a continuous sand supply to the machines, roller racks for taking the moulds from the machines, coring up, closing and pouring, knocking out on a grate at the other end of the racks and returning the knock-out sand to the mixing plant by means of underground conveyor. After working out many schemes that arrangement seems to be the most generally applicable. This system is being tried out up and down the country, and, moreover, in several places where a few years ago they said they could not use conveyors. For heavy work, say with a sand-slinger, the crane has to be used for handling the boxes, but the sand conveyor may still be employed for feeding the sand-slinger, and all moulds knock out on a common grating for return of used sand by underground pan-conveyor.

The author then showed on the screen a much more elaborate plant—the new Morris Foundry*—for the production of automobile engine castings. In this foundry there is a wholly continuous system. The moulds move continually on two heavy mould conveyors of the slipper-plate type.

As the moulds are made up entirely of cores, the sand used is only backing sand, but this is

* A Paper read before the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen, Mr. E. H. Tyson presiding.

* F.T.J., Vol. 41, page 228, *et. seq.*

brought to the moulders on a very extensive flight conveyor scheme. The core-work and the transportation of cores is very interesting. These are baked in two continuous core stoves. They are conveyed to and from both of these stoves by an extensive system of overhead pendulum conveyors. This system not only forms a store for the cores, but delivers them in a continuous stream behind the moulders.

How the results of these continuous ovens compare with the more simple type is difficult to visualise, but for ordinary foundry work the author inclines to a battery of simple stoves where the moulds are stored on racks, the racks being pushed into the stove on elevating trucks at one end, and taken out by similar means at the other, where they can be lifted bodily by a crane and deposited in convenient positions for the moulders. This is a simple and effective scheme, and much more suitable for general purposes than the very elaborate continuous scheme dealt with. The latter is no doubt justified in that particular case by the very large amount of cores required for the method of moulding employed.

Dry sand work is a difficult problem for the conveyor specialist. It has recently been dealt with by means of a pendulum conveyor, but in this case the moulds were small, the completed mould made up of three sections only weighing about 120 lbs. In this case the moulds were so delicate that every part was carried by hand into the stove, and the next morning carried out of it for making up. There was a tremendous amount of walking done by each moulder, and the case was dealt with by arranging the machines in line and running a pendulum conveyor alongside the machines, so that the moulders could place their finished moulds on to the pendulums, and as these passed in front of the stoves a man could, in an hour or two, transfer them from the pendulums to the stoves. When removing from the stove, the moulds were again deposited on the pendulums running in front of the stoves, and these in turn delivered them along the backs, where the operators cored them and closed them for pouring. The system was not ideal, but a considerable improvement on the old method. It saved much time in getting the moulds in and out of the stoves; the same pendulum conveyor was used for conveying the cores, and the whole system had the advantage of a common knock-out and a continuous sand supply to the moulders.

Industrial Research.

A suggestion that closer co-operation was necessary between the Scottish Universities and industrial institutions was made by Principal R. S. Rait, of the Glasgow University, in proposing the toast of the Institution of Electrical Engineers at the annual dinner of the Scottish centre of that Institution. The Principal said that when visiting the United States of America he was much impressed by the close relationship he found between the universities and the great industrial corporations. He came across instances of the engineers to these corporations recommending to the directors that if research and investigation along a particular line was proposed, he should go to the university and ask the staff there to undertake the research. That, he understood, was done on a large scale in America, but was only adopted on a very small extent in Scotland. He trusted that in the near future such co-operation would become not a rare thing but quite a common occurrence. The Universities and the Institutions might be mutually helpful if such were the case.

Permission to deal in the shares of the Metals Coating Company, Limited, has been granted by the Stock Exchange.

Close Works, Gateshead, Visited.

On the afternoon of Saturday, November 23, 1929, a party of about 100 members of the Newcastle Branch of the Institute of British Foundrymen visited the Close Works of Messrs. Sir W. G. Armstrong, Whitworth & Company, Limited, Gateshead.

These works are situated at Gateshead, and cover an area of about 10 acres, adjoining the L.N.E.R. line to Sunderland. About 550 men are employed. The shops are well equipped with moulding machines, latest types of sand-mixing plant, and also a sand-slinger equipment. The shops are extremely well lighted and have good ventilation. The chief productions include steam turbine castings for land and marine work, castings for marine reciprocating steam engines, Diesel engines, etc., locomotive cylinders and general locomotive castings. Also all classes of castings for heavy-duty hydraulic work. The foundry specialises in high-duty castings for Diesel engine work, such as liners, piston-heads, skirts, etc. A number of liners are in use in ships at sea, and these are showing excellent wearing properties. The castings produced range from a few pounds to 30 tons in weight. Castings for general engineering work are also produced.

The melting plant of this foundry is considered one of the most efficient in the country. It consists of one 12-ton cupola and three 7-ton cupolas. The charging arrangements are particularly effective, and enable 120 tons of metal to be charged per day, with six men. The foundry is equipped with 18 pits for heavy casting work, and a further extension is now under construction.

Castings are cleaned and fettled by the aid of a sand-blast plant, capable of dealing with castings up to 5 tons in weight. Extensive use is made of pneumatic hammers in the fettling shop.

There is a well-lighted patternshop, approximately 250 ft. long by 50 ft. wide, capable of accommodating 100 patternmakers. This shop is well equipped with plant, including Wadkin wood-worker, etc. In the pattern store some 30,000 patterns are kept, ranging from a few ounces to 4 tons in weight, and any one particular pattern can be produced in a few minutes.

A large business is also done at these works in the production of special refined pig-iron. Four stock grades are manufactured, and, in addition, special grades to suit customers' own analyses. These irons are specially suitable for the manufacture of high-duty castings, such as motor cylinders, Diesel castings, hydraulic machinery, etc., which require close grain, hard-wearing iron of known properties. In this department the chemical laboratory plays an important part, as a close check is kept on all incoming materials as well as outgoing shipments.

At the present time the foundry is very fully employed, but the extensions now in progress will enable the output to be considerably increased.

After tea, to which the party was entertained by the company, Mr. V. Stobie proposed a vote of thanks to the company, and also to Major Bird, Mr. Scott and their colleagues for so kindly conducting them around the works that afternoon. At the Close Works they seemed to be able to make anything from a sixpence to a Diesel engine. He had been astounded by the size of the works, for, although he knew of them by reputation, he had had no idea of their size.

Mr. Weir seconded.

Major Bird, replying to the vote of thanks on behalf of the company and staff, said that it gave them very great pleasure to welcome them, and he was sure that anything the staff had been able to do in showing them round, they had been only too pleased to do it. He would much have preferred their visit to have been three months later, for at the present time they were making additions to the works, pulling down the old foundry and making a new building. They were also full up with work, and were trying to keep up a big output and do the extensions. They were consequently in rather a state of confusion. They were going to get in new machines, which would be the only ones of their type in the country, in the next four or five months. However, if any of them wished to visit the works at a later date, they would be only too pleased to show them round.

An American Study of Liquid Shrinkage.

Progress in the investigation of the problem of liquid shrinkage, being carried on through the co-operation of the American Foundrymen's Association and the Bureau of Standards, is indicated in a report submitted by E. J. Ash, Research Associate for both organisations, to the committee on cast iron of the American Foundrymen's Association.

The first investigations were carried out on cone-shape specimens cast in dry-sand moulds. The external pipe and internal voids were determined by weighing, filling the pipes with wax, and calculating the volumes. However, true shrinkage values could not be obtained, due to non-uniformity of metal temperature, and because a volume change takes place in some of the metal during the casting period.

Consequently, a new procedure was developed, which is termed the crucible immersion method. This consists in immersing a crucible of known volume into a ladle of molten metal and filling the cavity of the crucible, allowing sufficient time for the crucible and the metal to reach a temperature equilibrium. When this state is attained a lid is pressed down firmly on the crucible and the whole removed from the melt. After cooling, the resultant ingot is weighed, and through the known volume of the crucible the specific volume value of the metal at the temperature of sampling may be determined. Results obtained with 98.5 per cent. aluminium show a solidification shrinkage, based on liquid volume at 656 deg. C., of 6.4 per cent. This method only can be used to collect data for constructing the specific volume curve of the liquid metal. Also it will be possible to express the relative tendency of metals to distribute their solidification shrinkage between external pipe and internal voids. This distribution may be largely a function of the quantity of the heat contained in the lid, which acts as a hot top. Similar data will be obtained for zinc, No. 12 aluminium alloy, lead and probably the 85-5-5-5 brass. Following these the work will continue in collecting data on cast iron.

Contributions to Charities.

The employees of Messrs. James Howden & Company, Limited, engineers and founders, Glasgow, have contributed the sum of £265 to infirmaries and other philanthropic institutions.

The employees of the Ardrossan Dockyard, Limited, have subscribed the sum of £150 to infirmaries and institutions during the past six months.

The employees of Messrs. Kerr & Company, Limited, Caledonia Foundry, Glasgow, have contributed £32 to charities for the year ended September 30.

During the past twelve months the employees of Messrs. Babcock & Wilcox, Limited, Renfrew, have contributed the sum of £1,909 to various benevolent institutions in Glasgow and vicinity.

Notes on Alloy Steels.

SOME LESSER-KNOWN FACTS.

At a meeting of the Institution of Engineers and Shipbuilders in Scotland held on November 19, PROF. J. H. ANDREW read a Paper on "Some Lesser-Known Facts Concerning Alloy Steels," in the course of which he remarked that practice had shown that the smaller the dendritic pattern, in the cast state, usually the better was the ingot. That only served to emphasise the importance of casting conditions, and of obtaining an ingot in a sound condition.

The engineer (continued the author) depends on the result of mechanical tests, and it was of interest to note the relation between the dendritic structure and the mechanical properties. The tests in Table I were taken from a nickel-chromium-steel ingot. Slabs were cut from the casting, and after further machining into smaller pieces suitable for preparing mechanical test-pieces, each piece was normalised, oil-hardened and tempered.

TABLE I.—*Mechanical Tests from Same Ingot.*

Position of test in ingot.	Radial or cross section.	Yield stress. Tons.	Breaking stress. Tons.	Elongation. Per cent.	Reduction of area. Per cent.	Izod test. Ft.-lbs.
Near outside wall.. ..	R.	45.0	56.6	20.0	48.0	67.0
	C.	47.0	57.0	17.5	34.0	53.5
Midway between outside and centre ..	R.	47.2	56.2	16.5	36.0	46.0
	C.	42.0	55.5	16.0	31.0	61.0
Near centre ..	R.	49.0	57.6	17.5	44.0	34.0
	C.	45.0	55.8	12.0	24.0	31.5

A thick slab cut from the ingot from outside to centre, after being sectioned into three pieces representing outside, middle and centre, was forged down in a direction perpendicular to the columnar crystals. Test-pieces were then cut, normalised, and oil-hardened and tempered, and the results are shown in Table II.

TABLE II.—*Results of Tests from a 45-ton Ingot.*

Position of test in ingot.	Longitudinal or cross section.	Yield stress. Tons.	Breaking stress. Tons.	Elongation. Per cent.	Reduction of area. Per cent.	Izod test. Ft.-lbs.
Outside ..	L.	40.0	58.8	21.5	53.0	60.0
	C.	42.0	58.7	16.5	41.0	41.0
Middle.. ..	L.	44.0	56.5	24.0	53.0	74.0
	C.	42.0	56.8	19.0	44.0	77.0
Centre.. ..	L.	44.0	56.0	20.5	53.0	84.0
	C.	43.0	56.5	19.0	47.0	47.0

The slabs for this treatment were taken from the same 45-ton ingot. The results are of interest, inasmuch as they show that a correctly heat-treated large casting, provided it is sound, will give mechanical tests almost equal to those of a forged and treated ingot. It is of interest, further, to note that in the test taken from the unforged casting from the section composed of the elongated crystals, those taken across these columnar crystals give results almost equal to those taken over their length. This was a remarkable and unexpected result.

Advantages Associated with Hot Work.

If these tests (continued the author) are compared with those taken from the finished-forged and treated job, which was a hollow forging, and, therefore, had been hot-worked to a very considerable extent, the high value for the as-cast figures will stand out as being even more remarkable. The following are the results:—Yield stress, 48.0; breaking stress, 58.0 tons; elongation, 21.0; reduction of area, 57.0 per cent.; Izod, 41.0 ft.-lbs. These test results, along with many others, serve to show that, except for sealing up blowholes and small cavities, the operation of hot forging has not quite the redeeming features usually attached to it. Further, from a number of forgings examined, varying from 45 to 11 tons in weight, the smaller forgings usually gave better results. The finished job as made from these varying sizes of ingots was the same.

The objection to a large forging, as compared with a smaller one, is that the squeezing action may not penetrate as deeply into the centre as it would do in a forging of smaller section. Since the structure of all cast steel is essentially dendritic, and forging operations serve to draw out the dendrites into what appear to be long fibres, it is not difficult to imagine that if forging be carried to an extreme degree, the strength of the finished article will all lie in one particular direction with reference to these fibres, and the corresponding test taken across them will be comparatively weak.

Constitution and Mechanical Strength.

The author holds the view that if the strength of steel be measured in some energy factor, which for any particular steel may be a constant, the forging operation can only resolve this factor so that it increases in one direction, with a corresponding decrement in another direction at right angles, or, in other words, an excessively high maximum-stress along the longitudinal direction will be balanced by a correspondingly low value in the cross direction. That the mechanical strength does not depend upon the direction of the fibres entirely is shown by the fact that heat treatment carried out after forging, or even finishing the forging at high temperature, will largely militate against this directional effect, but even so, the directional influences of the dendrites will still be present.

The strength of any alloy composed of two constituents, as in the case of steel in which the constituents are carbide of iron and free iron containing certain elements in solution, is dependent upon, amongst other factors, the grain size and distribution of the constituents. Grain size may affect different alloys differently. For instance, in certain cases large grains are associated with a high elongation and low breaking-stress, and in others with a low elongation and correspondingly higher breaking-stress is compared with a smaller grain size.

Generally, it is to be inferred that if there is present along the grain boundaries a hard constituent, such as carbide of iron, the elongation may be low and the maximum stress higher, while if the grains are composed of a homogeneous material with no separate constituent at the boundaries, the elongation will be high, again as compared with a smaller grain size. It is usually desirable, excepting where steel is used for drawing into wire, to obtain the grain size as small as possible. Actual grain size does not seem to be as important, however, as the distribution of the sorbite and ferrite in the structure.

Formation of Carbides.

Such metals as nickel and chromium, when added to iron in small amounts, between 1 and 4 per cent., do not have any great effect on the mechanical properties; when added to steel, however, their effect is very considerable. This only goes to show that the alloying elements in some way affect the conditions of the carbide. What this effect is, is readily seen by a micro-examination.

The author suggests that the carbide acts as a kind of reinforcing material with respect to the iron matrix, the increment in strength brought about by its presence being due to the surface tension between the carbide particles and the iron. It is then obvious that the greater the carbide surface, the more effective will this action be. If, for example, a nickel-chromium steel of the composition cited be quenched from a high temperature in some suitable quenching medium, a molecular distribution of the carbide is arrived at, with the result that a maximum stress of over 100 tons will be obtained.

In the quenched state, however, a steel is in a state of metastable equilibrium, and inherent stresses that accrue from such treatment are liable to make the steel crack spontaneously, either when under load or not. It is only reasonable to assume that a steel in the most stable state is safer to use than one which is not. For these reasons, if a high maximum-stress is required, it is better to employ an alloy steel which will give the necessary figures in the completely tempered state, rather than one which can only be relied upon to give similar figures when in the semi-tempered state.

TABLE III.—*Comparative Results on Steels of Small Section.*

Carbon.	Nickel.	Chromium.	Oil-Hardened. Deg. C.	Tempered. Deg. C.	Yield stress. Tons.	Maximum stress. Tons.	Elongation. Per cent.	Reduction of area. Per cent.	Izod. Ft.-lbs.
0.42	2.02	1.04	900	650	46.0	55.7	20.0	50.0	57
0.42	1.90	2.15	900	650	45.0	55.0	20.0	46.0	46
0.37	2.81	1.34	900	650	32.5	47.0	22.0	51.0	46
0.35	3.0	1.49	900	650	42.8	53.6	18.0	45.0	43
0.30	3.5	0.79	870	650	48.5	57.5	23.0	59.0	60
0.30	3.5	1.79	870	650	36.0	48.0	28.6	53.0	60
0.35	3.5	Nil	850	650	48.5	55.5	23.5	61.0	90
0.35	Nil	2.8	870	650	47.2	54.0	24.0	62.6	92

Choice of Alloy Steels.

Table III shows the effect of varying the amount of nickel and chromium with a constant carbon content. The data embodied in this table refer to small bars and not large masses of steel, and it is with respect to the question of mass that the composition of the steel is of great importance. Judging by the tensile results in Table III, more than 2 per cent. of nickel or 1 per cent. of chromium is unnecessary. Provided only small sections are considered, this appears to be the case, and greater quantities of these elements are superfluous. As a comparison, a plain nickel and plain chromium steel have been included in the list.

In parts used for automobile construction, that is to say, sections of relatively small dimensions, it is not at all obvious why the nickel content in particular is kept as high as occasionally found. When dealing with large masses, however, a nickel content of about 3.5 to 4.0 per cent. has many advantages.

Depth Hardness.

The operation of oil-hardening is subscribed for the purpose of cooling the steel rapidly through the temperature of transformation, in order to retard that transformation, and so cause it to occur at a temperature lower than the normal. Law has shown that in large masses the rate at which the centre of any large steel section cools is not greatly affected by cooling in a quenching medium. This being the case, it is obvious that in any large mass the temperature at which the transformation will take place at the centre will not depart very far from the

normal. If, however, a material is selected in which the transformation naturally takes place at a lowered temperature as compared with a plain carbon steel, the desired result is obtained. Thus, instead of, as is the case with plain carbon steels, having to quench drastically in order to lower the transformation sufficiently to produce a fine structure, the same conditions are more easily obtained by the addition of some special element.

Temper Brittleness.

In view of what is known as "notch-bar brittleness" being a property of most nickel and nickel-chromium steels—the property of the steel being brittle unless water-quenched from the tempering temperature—it is of interest to consider the reason for this peculiarity. The differences in the Izod test between a bar which has been quenched in water after tempering and one which has not may amount to as much as 90 ft.-lbs. This brittleness, the author suggested, is due to the precipitation of thin films of carbide at the grain boundaries during tempering.

Quenching Temperatures.

Continuing, the author said the question of initial temperature (*i.e.*, the maximum temperature from which a steel is cooled) is of great importance in the case of alloy steels. In a plain carbon steel, whatever temperature the steel be heated to, within certain limits, the transformations occur on cooling at the same temperatures. It is not generally appreciated that with alloy steels this is not so. If a steel containing approximately 0.35 per cent. of carbon, 3.5 per cent. of nickel and 2.0 per cent. of chromium be heated to and cooled slowly from 770 deg. C., the usual transformation will occur at about 600 deg. C., and the resulting material will have a Brinell hardness of about 200. If, however, the same sample be heated to and cooled from a temperature of 850 deg. C., the transformation will not occur until the temperature of 430 deg. C. has been reached, and on account of the lowering of this transformation by temperature, the resulting material is considerably harder; usually the Brinell hardness is about 350. This is of importance in this way. If it is desired to soften the steel for machining, obviously a temperature of 750 deg. C. should not be exceeded. If the carbon content be raised to 1 per cent., the nickel and chromium being kept as before, cooling from 770 deg. C. will, as before, give a transformation point at about 600 deg. C., with a resulting Brinell figure of 270, whereas if the initial temperature of heating be 100 deg. C., the transformation point will be lowered to the neighbourhood of 150 deg. C., and the Brinell hardness will then be about 600. As a result of the varying effect of temperature, when it is required to soften for machining any nickel-chromium or certain other alloy steels, the safest method is to temper the steel at about 650 deg. C., followed, if possible, by a fairly rapid rate of cooling.

Influence of Rate of Cooling on Fracture.

If certain nickel-chromium steels be quenched in water after tempering at 650 deg. C., and then fractured, it will be found that the fracture is quite fibrous; if, on the other hand, tempering be carried out at a lower temperature, say, 550 deg. C., and slow cooling be adopted after the treatment, the resulting fractures will usually be crystalline, due to the thin films of carbide being precipitated around grain boundaries. Moreover, the resulting crystal grains are usually very large, which tends to show that two possible grain structures exist in the steel—a small-grained structure which is brought out by a high-temperature tempering, and a coarse structure brought out by a low-tempering treatment. It might be thought that alloy steels are more difficult to treat than plain carbon steels. Exactly the reverse is the case, however, for in alloy steels the changes that take place occur much more slowly, and are, therefore, more easily controlled. Further, on account of the presence of the special elements, the diffusion factor will have a greater influence in preventing grain growth, so that a small-grained fine structure is easily obtained.

In a carbon steel, the transformations take place with such rapidity that, in large sections, it is almost impossible even so much as to modify the structure in the centre of the mass by means of quenching in either oil or water.

Catalogue Received.

A New Aluminium Alloy. — "Cindal Aluminium Alloy" is the title of a handsome brochure prepared by Messrs. D. & J. Tullis, Limited, of Clydebank, Scotland. It contains 84 pages and some 50 illustrations dealing with a large number of truly scientific experiments. As a technical production it is one of the most brilliant we have ever handled, but a really serious commercial mistake has been made by not incorporating some sort of index. The busy engineer cannot be expected to read a treatise on the subject, no matter how interesting.

The experiments described consist of a number of sea-water period immersion tests, the samples consisting of a number of standard alloys and special ores. It was found that certain alloys resisted corrosion admirably but had poor casting properties. Therefore, attempts were carried out to improve these and resort was made to the chlorinisation method—a method created by Mr. Tullis himself and one which the metallurgical world has fully recognised as being an ingenious, novel and useful method of investigation. Unfortunately, it develops large grain size.

The book under review shows clearly that Mr. Tullis has the true research mentality and creative genius. As sea-water experiments are long and tedious, a spray test was developed as a means of giving reliable accelerated test results. The rationale of modification of alloys, especially the 12 per cent. silicon aluminium variety, is disclosed for the purpose of leading up to those permanently modified by the addition of boron; unsoundness may result, but on treating with chlorine, soundness is assured, although at the expense of a coarse-grained structure. When boron-chloride was used, both benefits were achieved and the coarse-grain-throwing properties of alloys were extensively studied and overcome. Finally, protective film-forming alloys were developed from boron refined alloys, which, owing to their purity and high nuclear-throwing capacity, can be considered as being extremely resistant to corrosion.

This section occupies 70 pages of the booklet and the balance is devoted to a specific statement of the properties of the four alloys derived from the previous tests. They are designated E 11 A (chill or sand castings), E 11 B (sand castings), L 316 (for sand castings up to ½-in. section and die castings), and 50 A designed to replace cast iron where lightness and corrosion resistance are required. They are shown by the salt-spray test to be corrosion resistant in the order given. A striking example is given by detailing the number of grains to be found in a cube of 125 cub. mm. in a normal unrefined alloy.

Intelligent instructions for the melting and casting of Cindal alloys are then detailed, and contain a wealth of sensible advice. Finally, there is an announcement that Cindal alloys have been placed on the market for utilisation by other non-ferrous founders, and they may receive the benefit of what has obviously been an expensive and large-scale series of intelligent tests.

Sand Preparation and its Relation to Continuous Moulding.

(*Continued from page* 406.)

Plant Details.

After leaving the magnetic separator the sand passes through a rotary sieve and falls into the semi-finished sand hoppers, from which it is admitted by the operator to the four pan mills through hand-controlled valves fitted at the bottom of each hopper. The four pan mills are each 6 ft. 10 in. dia., all shafts being carried in dust-proof ball bearings. Each pan is furnished with two cast-iron rollers, one having V-shaped grooves turned in its surface, the other being of a plain cylindrical pattern. Ploughs are fitted to each pan for thoroughly breaking up and aerating the sand.

The rollers, which are suspended are free to revolve, do not come into contact with the floor of the pan, consequently the sand is not crushed and damaged but is thoroughly mixed. All driving shafts run in totally enclosed dust-proof ball bearings, the rest of the bearings being lubricated by means of the grease gun. The pan mills are machined on the inside and balanced to ensure accurate running. The conveyor and elevator belts are made of a special quality rubber and canvas material, about ⅜ in. in thickness, so as better to withstand the wear associated with this type of work. The elevator buckets are heavily galvanised.

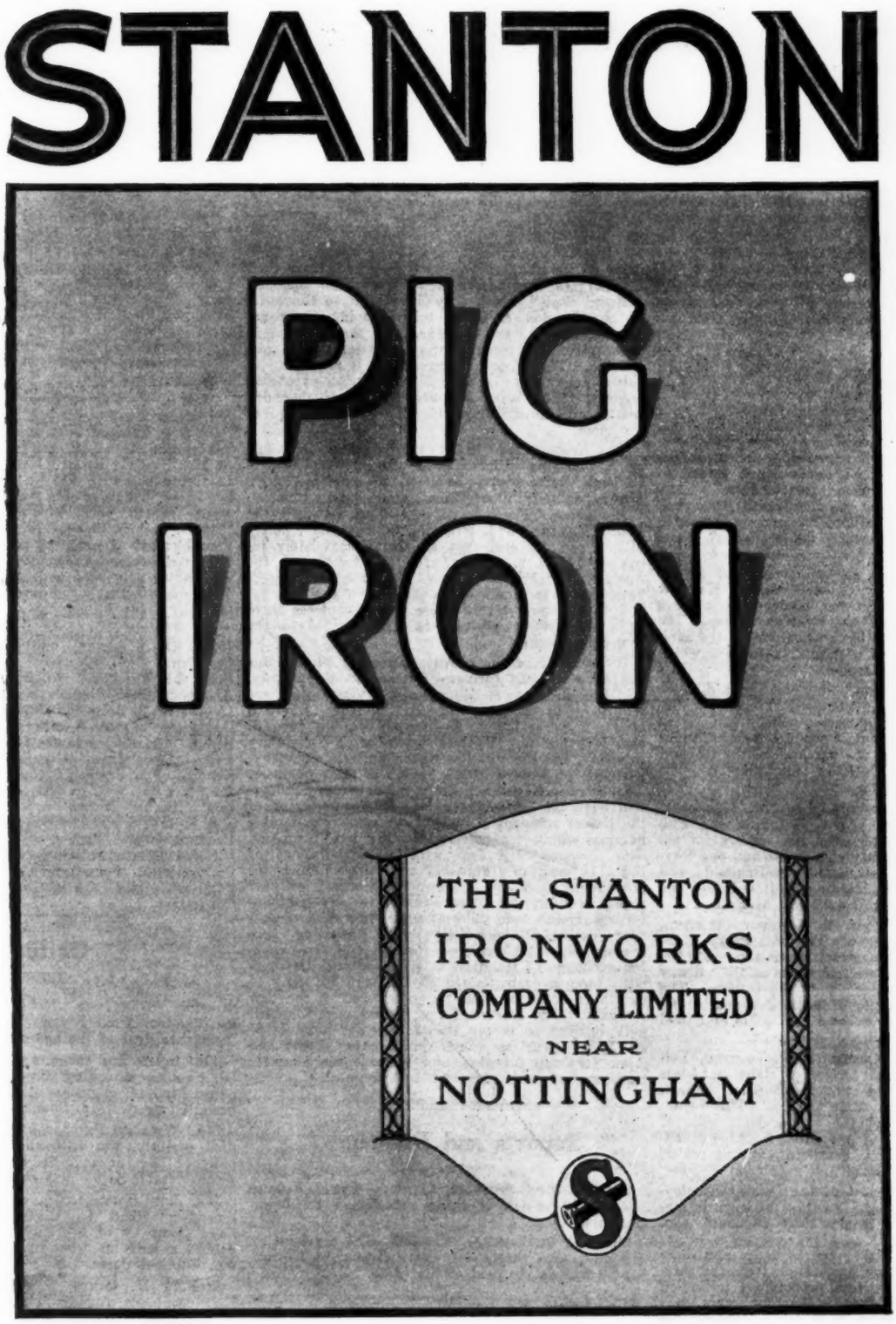
When the sand is thoroughly mixed and the requisite amount of moisture has been added a steel scraper is lowered by means of a hand wheel, and by this means the sand is pushed through a hole in the centre of the pan into a shute which discharges it into the base of a second bucket elevator. The semi-finished sand is again elevated to the top of the plant and passes it through an aerator, or revivifier, which thoroughly breaks it up and aerates it. From the aerator the sand is delivered into a finished sand hopper and is ready for use, the hopper being of ample capacity to ensure a continuous supply of clean fresh sand of high quality.

In the case of the semi-automatic sand-mixing plant outlined, the finished sand hopper is situated at the top of the building. The sand therefrom is discharged by a valve provided for the purpose into bottom discharge narrow-gauge wagons, which travel on rails on a gantry running the whole length of the shop. The wagons are man-handled and the sand is discharged from them into large sand-storage hoppers, each having a capacity of about 5 tons of sand. The sand is shovelled into the boxes by the machine operators.

Unquestionably the best system of sand conveying from sand plant to moulding machines is by overhead conveyor belts discharging into hoppers situated immediately over the moulding machines. Shovelling sand into the boxes is a pure waste of energy, time and money.

With regard to the life of this type of sand plant, the author recently inspected one which had been in service for six years in a large steel foundry in Paris, where the conditions, due to the heavy class of sand employed, are particularly severe, and, further, for the last twelve months the plant has been working continuously day and night, excluding only Sundays. Here the only replacements consist of the elevator belts and buckets and one new driving pinion. There are over one hundred of these plants in use on the Continent of Europe, Great Britain and India of capacities ranging in the case of a single-pan plant from 2¼ to 3¾ tons of finished sand per hour, up to plants with eight pans having a capacity of 30 to 35 tons per hour.

A cable from Johannesburg states that the South African Railway Administration has placed an order with Messrs. Beyer, Peacock & Company, Limited, of Manchester, for six locomotives, estimated to cost about £97,000.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Trade Talk.

The Midvale Company, of Nicetown, Philadelphia, U.S.A., is licensed to produce certain steel alloys developed by Sir Robert Hatfield.

Since April the works of the L.M.S. Railway Company at St. Rollox, Springburn, Glasgow, have been on short time, but on November 25 full-time working was resumed in practically all departments.

Ford Motor Company, Detroit, U.S.A., is reported to have concluded arrangements for the purchase of a site at Gdyniawith, Poland, for a new assembling plant to cost more than $650,000 (about £133,200), with equipment.

The Scottish Manufactured Iron Trade Conciliation and Arbitration Board certifies that the average net selling price for September and October was £10 14s. 1.32d. This means that there will be an increase of 2½ per cent. on basis in the wages of the workmen.

On November 27 about 100 members of the Derby and Derbyshire Chamber of Commerce made a tour of Messrs. Rolls Royce Works at Derby, and spent a very interesting and instructive time in studying the development of a Rolls Royce engine from the embryo birth to maturity.

Messrs. Harland & Wolff, Limited, have received orders for two cargo steamers, each of 9,000 tons deadweight, to be built at their Govan shipyard. The orders have been placed by the Earl of Inchcape, one for the Norse Line and the other for the Hain Steamship Company, Limited, Cardiff.

The Derby Society has awarded the medallion for the session to Mr. E. Jones for a Paper on "Recording and Indicating Instruments." Mr. J. W. Chambers received the President's prize, and the prize for the "ten-minute Paper" was awarded to Mr. J. W. Johnson, whose subject was "Diesel Electrical Rail Cars."

On November 22 an explosion occurred at the Dowlais Ironworks of Messrs. Guest, Keen & Nettlefolds, Limited, causing damage to a large dust-catcher and some of the hoist machinery. The explosion is believed to have been due to the ignition of an accumulation of gas in a furnace which was about to undergo repair.

Mr. W. J. Moggridge, joint managing director of Messrs. Allen West & Company, Limited, manufacturing electrical engineers, stated last week that the company had almost completed negotiations with the War Office for the purchase of the Government rolling mills at Woolston, Southampton. The site covers an area of 82 acres.

International Combustion, Limited, 11, Southampton Row, London, W.C.1 (Grinding and Pulverising Offices), have obtained new orders for six Hum-mer screens, two Raymond mills and one Raymond pulveriser, for installation in England; and one Raymond mill, one Hardinge ball mill and one Raymond pulveriser for installation in France.

Messrs. Edward Wood & Company, Limited, constructional engineers, of Trafford Park, Manchester, have secured a contract worth about £50,000 in connection with the electrification of the railway line between Manchester and Altrincham. The contract is for the supply of latticed supports and braced cross-beams for the overhead cable and steel work for about nine miles of the track.

Messrs. Workman, Clark (1928), Limited, Belfast, have completed the second of eight high-class vessels which they have built for Messrs. Andrew Weir & Company's Bank Line services. This vessel, the "Trentbank," is of the shelter-deck type, of 5,060 tons gross, and has propelling machinery constructed by the builders, consisting of one set of direct-acting inverted quadruple-expansion engines.

According to the report of the Paisley Employment Committee, the local position as regards employment is less satisfactory than a month ago. Local shipbuilding firms were experiencing a rather lean time, with very little work in hand, and there is a likelihood of further suspensions from the shipyards. There is also a very pronounced falling-off in the ironfounding industry, the number of men unemployed being greater than for a considerable time.

November has been a lean month for the Clyde shipyards, the output for the month being only nine ships, aggregating 18,648 tons, this output being the lowest since 1927. The total for the eleven months has been 189 vessels, of 477,161 tons, and for the corresponding period of last year the figures were 169 vessels, of 601,067 tons. In November last year there was a spate of new work, but this year very few orders have been booked during the month.

The works of Messrs. Henry Bessemer & Company, Limited, Sheffield, are to be sold by auction this month. Recently the firm amalgamated with Messrs. John Baker & Company (Rotherham), Limited, and the conjoint concern is now operated as John Baker & Bessemer, Limited. Apparently it is thought that the whole of the orders can be carried out in the works of the new company, chiefly at Kilnhurst, and accordingly the Bessemer works and plant are to be sold.

Negotiations have been concluded by Yale & Towne Manufacturing Company, Stamford, Conn., U.S.A., manufacturers of locks, builders' hardware, chain hoists, etc., for the purchase of H. & T. Vaughan, Limited, Willenhall, manufacturers of similar products, with factory branch and distributing plant at London. The purchasing company will consolidate with the organisation, operating as a subsidiary unit. Present plants will be continued and expansion in output is planned.

The Caledon Shipbuilding & Engineering Company, Limited, Dundee, have launched from their Stannergate shipyard a new steel screw steamer, "Royal Scot," which they have built to the order of the London & Edinburgh Shipping Company, Limited, Leith, and designed for the carriage of passengers and general cargo between Leith and London. The propelling machinery is placed amidships, and consists of a single set of triple-expansion engines, steam being supplied by two single-ended boilers and designed to give the vessel a speed of 14 knots.

The Aggborough Sand and Gravel Quarries at Kidderminster have been acquired by Messrs. General Refractories, Limited, of Sheffield, from Messrs. John Williams (Birmingham Sand), Limited, Birmingham. These have now been renamed the Zenith Quarries, and, following the customary policy of the new owners, they are being completely re-equipped and modernised for the benefit of the consuming foundries. General Refractories, Limited, have extensive ramifications throughout the country, and the taking over of these quarries places them in a still better position to give service to the foundry industry.

On account of the greatly increasing demand for electric resistance furnaces for industrial purposes, and the wide range of trades for which they are required, the Electric Furnace Company, Limited, of 17, Victoria Street, London, S.W., has formed, and will be the sole proprietors of, a subsidiary company, the Electric Resistance Furnace Company, Limited, to deal with this branch of their business. The Electric Resistance Furnace Company, Limited, will have the advantage of the full co-operation of the parent company's staff, of whom a considerable number will be transferred to the new company. The company will deal with all installations of E.F.C.O. resistance furnaces and stoves, which are now being used for a very great variety of purposes, including heat treatment of ferrous and non-ferrous metals and alloys, enamelling and japanning, decoration of pottery, glass annealing, core drying, etc. The benefits of patents and agreements for exchange of technical information and drawings with foreign countries, in so far as they apply to resistance furnaces, will be transferred to the new company. The Electric Furnace Company, Limited, will continue to supply electric melting furnaces of all kinds, such as the Héroult, Ajax-Wyatt and Ajax-Northrup furnaces, and contract for complete metallurgical and electrical installations.

Reports and Dividends.

Sheffield Steel Products, Limited.—Credit balance of £40,170, which is being transferred to depreciation account.

Merry & Cuninghame, Limited.—The dividend on the preference shares for the half-year to November 30 will not be paid at that date.

Contracts Open.

Buxton, December 7.—Castings, etc., for the Town Council. Mr. F. Langley, borough engineer, Town Hall, Buxton.

Whitstable, Kent, December 9.—Cast-iron pipes and specials, for the Urban District Council. Mr. A. B. Baker, clerk, Whitstable.

Personal.

Prof. Ing. Dr. Mont. Frantisek Píšek, who is a member of the London Branch of the Institute of British Foundrymen, has been appointed Rector of the Czech Technical High School of Brno, Czecho-Slovakia. The ceremony of his installation will take place on December 7, and his lecture will be upon "The Foundry Industry in Czecho-Slovakia."

Mr. A. E. Poole, who recently resigned the position of blast-furnace manager at the Thorncliffe Ironworks of Messrs. Newton Chambers & Company, Limited, in order to take up an appointment with Messrs. Walter Scott, Limited, Leeds, has been the recipient of presentations from the staff and workmen of the blast-furnace department at Thorncliffe.

Lt.-Col. E. L. Johnson, director and secretary of the Cleveland Scientific and Technical Institution, Middlesbrough, has tendered his resignation owing to his acceptance of an important post elsewhere. Mr. D. J. McKenna, who has assisted Colonel Johnson for some years, will now take the post of secretary, and Mr. F. P. Wilson, J.P., President-Elect of the Institute of British Foundrymen, who has been a member of the Council since the foundation of the Institution, has, at the request of that body, accepted the position of honorary director.

Mr. S. C. Vessy, President of the W. W. Sly Manufacturing Company, Cleveland, Ohio, has been elected a director of the American Foundrymen's Association, to fill the vacancy caused by the death of Mr. H. Cole Estep. His election was performed in accordance with the by-laws of the Association, by letter ballot of the remaining directors. Mr. Vessy served once before as a director, from 1926-29, and is thoroughly familiar with American Foundrymen's Association policies and plans for the coming Cleveland Convention. His location in the Convention city and as a representative of equipment manufacturers' interests should, therefore, be of great value in making the 1930 annual meeting a successful one.

Mr. D. M. Avey, editor of "The Foundry," Cleveland, Ohio, has been appointed by Mr. Fred Erb, the President, to the chairmanship of the American Foundrymen's Association Committee on International Relations, filling the vacancy left by the death of the former chairman, Mr. H. Cole Estep. Mr. Avey was one of the American Foundrymen's Association delegates to the 1929 International Foundrymen's Congress in London, and for years has been an active member of the Association. He has served on a number of committees, and is at present chairman of the Committee on Programme and Papers. The Committee on International Relations, which he now heads, acts for the American Foundrymen's Association in connection with the triennial International Foundry Congresses.

Obituary.

Mr. Harry Noble, chairman and managing director of Messrs. Noble & Lund, Limited, machine-tool makers and ironfounders, Felling-on-Tyne, has died at the age of 68 years.

The death has taken place, in London, of Mr. W. Shanks, managing director of Shanks & Company, Limited, engineers and ironfounders, of Barrhead, Glasgow. Mr. Shanks was 72 years of age.

Mr. William Price, of Wellington, Salop, who died recently, was with the Haybridge Iron Company (1926), Limited, for about 50 years, and for a considerable period was employed as mill manager.

Mr. John Thompson, a steel smelter, was instantaneously killed in Blochairn steelworks of the Steel Company of Scotland when he stepped from behind a ladle in front of a crane locomotive and was knocked down.

Mr. C. H. Oakes, a well-known figure in the East Midlands foundry circles, died at his home at Riddings, Derbyshire, last week, at the age of 63 years. The deceased, who had been director and chairman of Messrs. James Oakes & Company, Limited, for the past nine years, was educated at Harrow. Mr. Oakes also controlled the Pye Hill Sanitary Pipe Works and the Selston Housing Company. The family's connection with the iron trade ended when their interest in the Alfreton Ironworks was taken over by the Stanton Coal & Iron Company.

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WE NOW NEED THE HELP OF HALF-A-DOZEN FOUNDRYMEN WHO WILL TRY OUT A RING OR TWO OF THE SAMPLE BRICKS WE WILL MAKE TO THEIR SIZE AND DELIVER TO THEM FREE IF THEY WILL KINDLY WRITE US WITH PARTICULARS.

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—A fairly active demand for this period of the year has recently developed in the Cleveland iron market, stimulated doubtless by the reduction of the Bank Rate and easier conditions of credit facilities, while the political outlook is regarded as rather more favourable to a continuance of stability in prices. Consequently consumers have been encouraged to purchase beyond immediate needs, and a few forward contracts have been negotiated over the early months of next year. Thus, with regard to the disposal of their output, Cleveland makers are not in any present anxiety. They have limited stocks and most of the iron is still required for the local steel furnaces. With regard to the export side, shipments for November show a heavy decline, and it is admitted that more iron is going into Grangemouth from the Continent than from the Tees. In other words, cheap foreign iron is again ousting Cleveland to a large extent from the Scottish market. Quotations remain unaltered, as follow:—No. 1 Cleveland foundry iron, 75s. per ton; No. 3 G.M.B., 72s. 6d.; No. 4 foundry, 71s. 6d.; No. 4 forge iron, 71s. per ton.

The market for North-East Coast hematite continues fairly active, with an advancing tendency of prices, and producers are now within measurable distance of balancing costs of production and realised prices. To do this they claim that East Coast mixed numbers must reach 80s., and, in fact, some producers are asking up to that figure now. But as a general rule 79s. per ton is quoted, and business is being done on this basis. On the North-West Coast, Bessemer mixed numbers are quoted at 77s. per ton, at works.

LANCASHIRE.—In the local markets for foundry pig there has been a fairly regular demand for deliveries of No. 3 quality iron against contracts, and makers continue to report extreme pressure at the furnaces in coping with orders in hand. In the meantime, quotations for Derbyshire and Staffordshire brands are firm at 77s. per ton, with quotations for Scotch iron maintained at from 92s. 6d. to 93s. 6d., all per ton delivered local stations.

THE MIDLANDS.—Buying in the local markets for foundry pig at the moment is on a restricted scale, little inducement being offered to extend forward commitments while prices are fixed so far ahead as the end of January next. Current quotations are as follow:—75s. for No. 3 Northants, 78s. 6d. for Derbyshire No. 3 and 79s. 6d. for North Staffordshire No. 3, delivered local stations.

SCOTLAND.—The Scottish pig-iron trade shows no improvement, and buyers are taking only a limited interest in the market. Home-produced iron seems to be gradually taking a second place, being slowly displaced by Continental and Indian iron, both basic and foundry. Quotations for Scottish foundry iron are unchanged at 76s. per ton f.o.t. furnaces for No. 3 quality, with 2s. 6d. per ton extra for No. 1 quality.

Finished Iron.

Reports from manufacturers in the Black Country area suggest little alteration in market conditions, and the demand for crown and cheaper grades of bars is decidedly dull. There seems to be little prospect of any early improvement. The price of crown bars varies from £10 to £10 10s., and of bolt iron from £9 to £9 7s. 6d. Little business is possible for the latter, as most of the orders for this class of iron are going to Continental works, whose product is so much cheaper. Iron from this source is quoted freely at £6 7s. 6d., delivered this district, for quite ordinary parcels, and good lines could be placed at £6 5s. There has been no change in the price of Staffordshire marked bars, which are quoted at £12 10s. at works, with a steady demand.

Steel.

Business on the Sheffield Exchange of late has developed a quieter turn, and transactions in the steel market have been on a restricted scale. There has also been a smaller demand for basic billets, as a result of sharper Continental competition. Acid billet requirements are small, and the slight improvement noted some time ago has almost disappeared. Wire-rod makers are also feeling the effects of the competition of cheaper imported rods. Quotations show no change, however, and are as follow:—Basic billets, soft, £7; semi-hard, £7 12s. 6d.; medium, £8 2s. 6d.; hard, £9 2s. 6d. to £9 12s. 6d.; Siemens acid billets, £9 10s.; basic wire rods, soft, £8 2s. 6d.; medium, £9 15s. to £10; hard, £10 10s. to £11; acid billets, £12 5s. to £12 10s.; steel hoops, £9 15s. to £10. The tone of the tinplate market continues steady, with quotations ranging around 18s. 9d. to 18s. 10½d. basis for coke qualities, net cash, f.o.b. Welsh ports.

Scrap.

Buying, except for urgent requirements, in the various markets for scrap material, is now reduced to very small proportions, and on Tees-side slackness of work at the foundries has slowed down demand for all grades of cast iron, with a further weakening of prices, best machinery qualities now being quoted at 66s. 6d. and ordinary at £62s. 6d. per ton, delivered. In the Midlands there are good qualities of scrap available. For heavy machinery cast-iron scrap in cupola sizes 70s. per ton is quoted, 65s. for ordinary heavy metal, and 60s. for light cast-iron scrap. In Scotland quotations rule as follow:—Machinery scrap, 68s. 6d. to 70s., and ordinary quality from 63s. 6d. to 65s., all per ton delivered local works.

Metals.

Copper.—A further setback in values of warrant copper has to be recorded, this notwithstanding the support of the professional element, mainly from American sources. Prompt metal has, however, been in short supply, due to the large amount of repurchasing which has been done recently. Buying is still taking place, and a further advance in prices would not be unexpected, as the difference between the values of rough bar and electrolytic copper is still large.

Closing quotations are :—

Cash.—Thursday, £69 10s. to £69 15s.; Friday, £69 2s. 6d. to £69 5s.; Monday, £68 7s. 6d. to £68 10s.; Tuesday, £67 7s. 6d. to £67 10s.; Wednesday, £68 17s. 6d. to £68 18s. 9d.

Three Months.—Thursday, £68 7s. 6d. to £68 12s. 6d.; Friday, £68 3s. 9d. to £68 5s.; Monday, £67 17s. 6d. to £68; Tuesday, £67 7s. 6d. to £67 10s.; Wednesday, £68 16s. 3d. to £68 17s. 6d.

Tin.—Surprise has been freely expressed in market circles at the result of last week's meeting of the Tin Producers' Association, which was immediately followed by a heavy decline in standard values of no less than £8 10s. at the close. The fall is regarded as attributable to disappointment at the scheme designed to regulate tin supplies put forward by the Tin Producers' Association, and to the fact that speculators who had been buying in anticipation of a more comprehensive scheme ceased to take any further interest in the market.

Official closing prices :—

Cash.—Thursday, £176 10s. to £176 15s.; Friday, £179 17s. 6d. to £180 2s. 6d.; Monday, £174 5s. to £174 10s.; Tuesday, £177 15s. to £177 17s. 6d.; Wednesday, £176 10s. to £176 15s.

Three Months.—Thursday, £179 10s. to £179 15s.; Friday, £182 15s. to £183; Monday, £177 5s. to £177 10s.; Tuesday, £180 15s. to £181; Wednesday, £179 10s. to £179 12s. 6d.

Spelter.—Since the decision of the Zinc Cartel not to renew the existing agreement for next year the market has been very irregular. Prices are very low and stocks are accumulating, and there is an active demand for zinc sheets at the reduced prices which are now ruling.

Daily quotations are :—

Ordinary.—Thursday, £19 17s. 6d.; Friday, £19 12s. 6d.; Monday, £19 15s.; Tuesday, £20; Wednesday, £20 3s. 9d.

Lead.—The market for soft foreign pig has been very erratic of late. Following the recent fall in sympathy with spelter, prices have been unsettled. Arrivals of metal have been ample, and the supply is more than enough to meet requirements.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £21 10s.; Friday, £21 10s.; Monday, £21 10s.; Tuesday, £21 10s.; Wednesday, £21 6s. 3d.

Publication Received.

West Hartlepool: Commercially Considered.—It seems to be the fashion for new enterprises to establish themselves south of the Trent, but a perusal of the contents of this pamphlet shows that the potentialities of the North-East Coast are well worth the closest investigation. We receive a number of this type of publication in the course of a year, and we throw out the suggestion that each city and town should, without committing themselves too deeply, in tabular or staccato form, compare their own with other towns' conditions as to taxation; gas, electricity and water supply; transport facilities; labour supply and availability of industrial sites. Housing, too, might usefully be indicated. This well-illustrated brochure will be sent to any of our readers on application to the Town Clerk, The Municipal Buildings, West Hartlepool.

Transvaal Engineers' and Founders' Association.

The following are the executives of the above Association for the year 1929-30:—President, Mr. D. M. Davidson; Vice-Presidents, Messrs. G. Bergstrom and J. A. Durie; Members of the Committee, Messrs. A. E. Lintott, J. N. Mackenzie, J. Shore, H. W. Blanchard, H. Bodilly, G. Barron (Treasurer), H. Santiaga, A. Hall, A. H. Moore, M.I.Brit.F., R. Lister and A. H. Guy.

The imports of foreign iron ore at the Prince of Wales Dock, Workington, during November amounted to 12,000 tons, compared with 6,000 tons in the previous month and 12,250 tons in November, 1928.

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REFINERY MIDDLESBROUGH.

ALSO MAKERS OF
HIGH CLASS REFINED PIG IRON
IN SMALL PIGS, FOR ALL KINDS OF
MALLEABLE CASTINGS

TELEPHONE:
MIDDLESBROUGH 4265.

WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash	68 17 6
Three months	68 16 3
Electrolytic	83 0 0
Tough	74 10 0
Best selected	75 0 0
Sheets	110 0 0
India	90 10 0
Wire bars	83 5 0
Do. Dec.	83 5 0
Do. Jan.	83 5 0
Ingot bars	83 5 0
H.C. wire rods	85 15 0
Off. av. cash, November	69 8 4 1/3
Do., 3 mths., November	68 19 3 1/4
Do., Sttlmnt., November	69 8 5 1/2
Do., Electro, November	82 19 9 1/2
Do., B.S., November	75 16 11 1/2
Do., wire bars, November	83 15 5 1/2
Aver. spot price, copper, Nov.	69 8 4 1/3
Solid drawn tubes	15d.
Brazed tubes	15d.
Wire	11½d.

BRASS.

Solid drawn tubes	12¾d.
Brazed tubes	14¾d.
Rods, drawn	12¼d.
Rods, extd. or rlld.	8d.
Sheets to 10 w.g.	11¼d.
Wire	10¾d.
Rolled metal	10¾d.
Yellow metal rods	8d.
Do. 4 × 4 Squares	8½d.
Do. 4 × 3 Sheets	9d.

TIN.

	£ s. d.
Standard cash	176 10 0
Three months	179 10 0
English	178 10 0
Bars	181 0 0
Straits	181 15 0
Australian	180 5 0
Eastern	178 15 0
Banca	188 15 0
Off. av. cash, November	180 13 7 1/2
Do., 3 mths, November	183 12 10 1/2
Do., Sttlmt., November	180 13 9 1/2
Aver. spot, November	180 13 7 1/2

SPELTER.

	£ s. d.
Ordinary	20 3 9
Remelted	19 0 0
Hard	17 5 0
Electro 99.9	22 7 6
English	20 7 6
India	18 10 0
Zinc dust (Nom.)	31 10 0
Zinc ashes	6 10 0
Off. aver., November	21 2 0 1/2
Aver., spot, November	20 17 0 1/2

LEAD.

	£ s. d.
Soft foreign ppt.	21 6 3
English	22 15 0
Off. average, November	21 12 7 1/4
Average spot, November	21 12 5 1/2

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	29 10 0
Do. V.M. ex-whf.	28 15 0
Rods	33 0 0
Boiler plates	26 10 0
Battery plates	27 0 0

ANTIMONY.

	£ s. d.
Special brands, Eng.	48 15 0
Chinese	31 5 0
Crude	20 0 0

QUICKSILVER.

	£ s. d.
Quicksilver	22 17 6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£7 17 6
45/50%	£11 10 0
75%	£19 0 0
Ferro-vanadium—	
35/50%	12/10 lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/2 lb. Mo.
Ferro-titanium—	
23/25% carbonless	1/- lb.
Ferro-phosphorus, 20/25%	£16 0 0
Ferro-tungsten—	
80/85%, c. fr.	3/1½ lb.
Tungsten metal powder—	
98/99%	3/4½ lb.
Ferro-chrome—	
2/4% car.	£30 10 0
4/6% car.	£23 5 0
6/8% car.	£22 0 0
8/10% car.	£21 15 0
Ferro-chrome—	
Max. 2% car.	£33 5 0
Max. 1% car.	£39 2 6
Max. 0.70% car.	£40 17 6
70% carbonless	1/- lb.
Nickel—99% cubes, or pellets	£175 0 0
Ferro-cobalt	9/6 lb.
Aluminium 98/99%	£95 0 0
Metallic chromium—	
96/98%	2/7 lb.
Ferro-manganese (net)—	
76/80% loose	£12 10 0
76/80% packed	£13 10 0
76/80% export	£13 0 0
Metallic manganese—	
94/96% carbonless	1/4 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 0
Finished bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ¼ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 3/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

South Wales—	£ s. d.	£ s. d.
Heavy steel		3 10 0
Bundled steel and shrngs.	3 5 0	to 3 9 0
Mixed iron and steel		3 5 0
Heavy cast iron	2 19 0	to 3 0 0
Good machinery for foundries	3 0 0	to 3 3 0
Cleveland—		
Heavy steel		3 3 6
Steel turnings		2 16 6
Cast-iron borings		2 13 0
Heavy forge		3 15 0
W.I. piling scrap		3 10 0
Cast-iron scrap	3 2 6	to 3 6 6
Midlands—		
Ord. cast-iron scrap		3 5 0
Heavy wrought		4 0 0
Steel turnings	2 7 6	to 2 10 0
Scotland—		
Heavy steel		3 12 0
Cast-iron borings		2 14 0
Wrought-iron piling		3 18 0
Heavy machinery		3 10 0

London—Merchants' buying prices delivered yard.

Copper (clean)	63 0 0
Brass	43 0 0
Lead (less usual draft)	19 10 0
Tea lead	16 0 0
Zinc	14 0 0
New aluminium cuttings	66 0 0
Braziery copper	57 0 0
Gunmetal	57 0 0
Hollow pewter	140 0 0
Shaped black pewter	100 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	75/-
Foundry No. 3	72/6
Foundry No. 4	71/6
Forge No. 4	71/-
Hematite No. 1	79/6
Hematite M/Nos.	79/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	86/-
,, d/d Birm.	93/6
Midlands—	
Staffs. common*	—
,, No. 4 forge*	75/6
,, No. 3 fdry.*	79/6
Shrops. basic	—
,, Cold blast, ord.	—
,, ,, roll iron	—
Northants forge*	71/-
,, fdry. No. 3*	75/-
Derbyshire forge*	74/6
,, fdry. No. 3*	78/6
,, basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	78/6
,, No. 3	76/-
Hem. M/Nos.	80/-
Sheffield (d/d district)—	
Derby forge	69/6
,, fdry. No. 3	73/6
Lincs. forge.	72/-
,, fdry No. 3	76/-
E.C. hematite	87/6
W.C. hematite	89/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	77/-
Northants foundry No. 3	—
Dalzell, No. 3 (special)	105/- to 107/6
Summerlee, No. 3	93/-
Glengarnock, No. 3	—
Gartsherrie, No. 3	93/-
Monkland, No. 3	93/-
Shotts, No. 3	93/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.) nom.		10 15 0
Nut and bolt iron	9 0 0	to 9 7 6
Hoops		11 0 0
Marked bars (Staffs) f.o.t.		12 10 0
Gas strip		11 0 0
Bolts and nuts, ¾ in. × 4 in.		15 5 0
Steel—		
Ship plates	8 12 6	to 8 17 6
Boiler plts.	9 12 6	to 10 10 0
Chequer plts.		10 12 6
Angles		8 2 6
Tees		9 2 6
Joists		8 2 6
Rounds and squares, 3 in. to 5½ in.		9 2 6
Rounds under 3 in. to ¾ in. (Untested)		8 2 6 and upwards
Flats—8 in. wide and over		8 7 6
,, under 8 in. and over 5 in.		8 12 6
Rails, heavy		8 10 0
Fishplates		12 10 0
Hoops (Staffs)		9 15 0
Black sheets, 24 g.	10 0 0	to 10 5 0
Galv. cor. shts., 24g.	12 12 6	to 13 2 6
Galv. fencing wire, 8g. plain		12 0 0
Billets, soft	6 2 6	to 6 12 6
Billets, hard	7 10 0	to 8 0 0
Sheet bars	6 0 0	to 6 10 0
Tin bars	6 0 0	to 6 10 0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/4
Sheet to 10 w.g.	1/5
Wire	1/6
Rods	1/5
Tubes	1/9½
Castings	1/4

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	10d. to 1/4
Rolled—	
To 9 in. wide	1/4 to 1/10
To 12 in. wide	1/4½ to 1/10½
To 15 in. wide	1/4½ to 1/10½
To 18 in. wide	1/5 to 1/11
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6 to 2/-
Ingots for spoons and forks	10d. to 1/6½
Ingots rolled to spoon size	1/1 to 1/9½
Wire round—	
3/0 to 10 G.	1/7½ to 2/2½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	21.26
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic	20.26
Bessemer	20.76
Malleable	20.76
Grey forge	19.76
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bessemer billets	35.00
O.-h. billets	35.00
O.-h. sheet bars	35.00
Wire rods	40.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.90
Tank plates	1.90
Beams, etc.	1.90
Skelp, grooved steel	1.85
Skelp, sheared steel	1.85
Steel hoops	2.20
Sheets, black, No. 24	2.75
Sheets, galv., No. 24	3.40
Sheets, blue an'l'd, No. 13	2.25
Wire nails	2.40
Plain wire	2.40
Barbed wire, galv.	3.05
Tinplates, 100-lb. box	$5.35

COKE (at ovens).

Welsh foundry	32/6 to 35/-
,, furnace	27/6 to 32/6
Durham and Northumberland—	
,, foundry	22/6
,, furnace	21/-
Midlands, foundry	—
,, furnace	21/6 and up

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box	18/9
,,	28×20 ,,	38/-
,,	20×10 ,,	27/6
,,	18¾×14 ,,	19/6
C.W.	20×14 ,,	16/-
,,	28×20 ,,	34/-
,,	20×10 ,,	22/7½
,,	18¾×14 ,,	16/-
Terneplates	28×20	33/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0 to £7 10 0
Bars, hammered, basis	£17 10 0 to £18 10 0
Bars and nail-rods, rolled, basis	£15 15 0 to £16 15 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£32 0 0 to £33 0 0
Faggot steel	£20 0 0 to £24 0 0
Bars and rods dead soft, steel	£11 0 0 to £14 0 0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.
Over ½ in. up to 6 in.

	Tubes.	*Fittings.*
Gas	65% ..	.. 47½%
Water	61¼% ..	.. 42½%
Steam	57½% ..	.. 37½%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

			£	s.	d.		
Nov.	28	..	69	10	0	inc.	10/–
,,	29	..	69	2	6	dec.	7/6
Dec.	2	..	68	7	6	,,	15/–
,,	3	..	67	7	6	,,	20/–
,,	4	..	68	17	6	inc.	30/–

Electrolytic Copper.

			£	s.	d.			
Nov.	28	..	83	0	0	No	change	
,,	29	..	83	0	0	,,	,,	
Dec.	2	..	83	0	0	,,	,,	
,,	3	..	83	0	0	,,	,,	
,,	4	..	83	0	0	,,	,,	

Standard Tin (cash).

			£	s.	d.			
Nov.	28	..	176	10	0	dec.	165/–	
,,	29	..	179	17	6	inc.	67/6	
Dec.	2	..	174	5	0	dec.	112/6	
,,	3	..	177	15	0	inc.	70/–	
,,	4	..	176	10	0	dec.	25/–	

Tin (English ingots).

			£	s.	d.			
Nov.	28	..	177	15	0	dec.	150/–	
,,	29	..	181	5	0	inc.	70/–	
Dec.	2	..	175	10	0	dec.	115/–	
,,	3	..	179	0	0	inc.	70/–	
,,	4	..	178	10	0	dec.	10/–	

Zinc Sheets (English).

			£	s.	d.			
Nov.	28	..	29	10	0	No	change	
,,	29	..	29	10	0	,,	,,	
Dec.	2	..	29	10	0	,,	,,	
,,	3	..	29	10	0	,,	,,	
,,	4	..	29	10	0	,,	,,	

Spelter (ordinary).

			£	s.	d.			
Nov.	28	..	19	17	6	dec.	5/–	
,,	29	..	19	12	6	,,	5/–	
Dec.	2	..	19	15	0	inc.	2/6	
,,	3	..	20	0	0	,,	5/–	
,,	4	..	20	3	9	,,	3/9	

Lead (English).

			£	s.	d.			
Nov.	28	..	22	15	0	No	change	
,,	29	..	22	15	0	,,	,,	
Dec.	2	..	22	15	0	,,	,,	
,,	3	..	22	10	0	dec.	5/–	
,,	4	..	22	15	0	inc.	5/–	

AVERAGE MONTHLY PRICES OF STEEL BOILER PLATES IN ENGLAND.

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1895	5 15 0	5 15 0	5 12 6	5 12 6	5 15 0	5 17 6	5 15 0	5 17 6	6 0 0	6 0 0	6 2 6	6 0 0	5 16 10½
1896	6 0 0	6 0 0	6 2 6	6 2 6	6 2 6	6 0 0	6 0 0	6 0 0	6 0 0	6 2 6	6 10 0	6 10 0	6 2 6
1897	6 10 0	6 10 0	6 10 0	6 7 6	6 2 6	6 2 6	6 5 0	6 0 0	6 0 0	6 0 0	6 7 6	6 10 0	6 5 5
1898	6 10 0	6 8 9	6 8 9	6 10 0	6 15 0	6 18 9	6 17 6	6 17 6	7 2 6	6 15 0	7 0 0	7 5 0	6 15 8½
1899	7 5 0	8 0 0	8 2 6	8 2 6	8 5 0	8 5 0	8 12 6	8 12 6	8 15 0	8 15 0	9 2 6	9 5 0	8 17 8½
1900	9 5 0	9 5 0	9 7 6	9 10 0	9 12 6	10 5 0	10 5 0	10 5 0	10 5 0	10 0 0	9 15 0	9 15 0	9 15 10
1901	9 5 0	9 5 0	8 15 0	8 10 0	8 10 0	7 10 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	8 3 11
1902	7 7 6	7 0 0	7 12 6	7 12 6	7 12 6	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 9 7
1903	7 10 0	7 10 0	7 15 0	7 5 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	6 17 6	7 3 11½
1904	6 12 6	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 11½
1905	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 10 0	7 5 0	8 0 0	8 0 0	7 1 3
1906	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 0 10
1907	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 0 0	8 0 0	8 8 4
1908	7 10 0	7 10 0	7 10 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 3 9
1909	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 15 0	6 15 0	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 9
1910	7 0 0	7 0 0	7 1 3	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 10 0	7 10 0	7 10 0	7 5 1
1911	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 14 0	7 10 4
1912	7 18 9	8 0 0	8 0 0	8 7 6	8 10 0	8 10 0	8 10 0	8 15 0	8 16 3	9 0 0	9 2 0	9 5 0	8 11 2½
1913	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	8 19 9	8 15 0	8 5 0	7 15 0	7 15 0	8 17 0
1914	7 15 0	7 15 0	7 15 0	7 13 9	7 10 6	7 5 0	7 0 0	8 0 0	8 2 6	8 5 0	8 5 0	8 5 0	7 15 11½
1915	8 14 0	9 10 0	9 17 6	10 10 0	10 10 0	11 0 0	11 0 0	11 0 0	11 0 0	11 4 0	12 0 0	13 0 0	10 15 5½
1916	13 0 0	13 0 0	13 0 0	12 15 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 12 11
1917	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1918	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1919	13 0 0	15 0 0	15 0 0	15 0 0	19 5 0	19 17 6	21 0 0	21 10 0	21 10 0	21 10 0	21 15 0	23 10 0	18 9 9
1920	26 0 0	28 0 0	28 5 0	28 10 0	29 5 0	30 0 0	30 0 0	30 0 0	30 10 0	31 0 0	31 0 0	31 0 0	29 9 2
1921	30 5 0	29 0 0	25 0 0	25 0 0	23 0 0	21 0 0	21 0 0	20 10 0	19 0 0	17 10 0	16 0 0	14 16 0	22 1 9
1922	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	13 1 8	13 10 0	12 15 0	12 10 0	12 10 0	12 10 0	12 6 0	13 10 9
1923	12 8 9	13 6 0	14 0 0	14 0 0	14 0 0	14 0 0	13 12 6	13 0 0	13 0 0	13 0 0	13 0 0	13 10 0	13 9 1½
1924	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	14 0 0	14 0 0	13 11 0	13 5 0	13 5 0	13 10 11
1925	13 5 0	13 5 0	13 5 0	13 1 0	12 15 0	12 15 0	12 15 0	12 15 0	12 7 6	11 14 0	11 10 0	11 10 0	12 11 5½
1926	11 10 0	11 10 0	11 10 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 6 3
1927	11 5 0	11 5 0	11 5 0	11 5 0	11 2 6	11 0 0	11 0 0	11 0 0	10 16 0	10 10 0	10 10 0	10 10 0	10 19 10½
1928	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0
1929	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 5 0	10 1 3	10 1 3	10 1 3	—	—

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,
19, ST. VINCENT PLACE, GLASGOW.
ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-.

(A remittance should accompany instructions.)

SITUATIONS VACANT.

FIRST-CLASS REPRESENTATIVE, Birmingham and Midland area, for sale of high-class pig-irons.—Reply, giving references and experience, also state salary required, Box 388, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN PATTERNMAKER required by large engineering firm near London; must be fully experienced in latest practice for machine moulding and able to fix piecework prices.—Give full particulars of experience, with references, to Box 392, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

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PATENTS.

THE Owners of British Patents Nos. 255718, 268025 and 258760, for Improvements in or relating to Steam Generators and Furnaces, are desirous of entering into negotiations with one or more firms in Great Britain for the purpose of exploiting the above inventions, either by sale of the patent rights or by the grant of a licence or licences to manufacture on royalty. —Inquiries should be addressed to MESSRS. ABEL & IMRAY, 30, Southampton Buildings, London, W.C.2.

THE Proprietor of British Patent No. 194078, dated January 23, 1922, relating to "Apparatus for Making Drop-forged Steel Car Wheels," is desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above Patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois.

THE Proprietor of British Patent No. 190928, dated January 18, 1922, relating to "Improvements in Drop Hammers," is desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above Patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois.

MACHINERY.

SAND MIXERS.—New and Secondhand. Ask us to quote.—W. BREALEY & COMPANY, LIMITED, Prospect Works, Hawksley Avenue, Sheffield.

MACHINERY—*Continued.*

FOR SALE, one Macdonald "Ajax" Pneumatic Jarring, Turnover and Pattern-Drawing Moulding Machine, their No. 24, but with table 10 ft. by 7 ft. Good condition, very little used.—Apply, Box 384, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

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